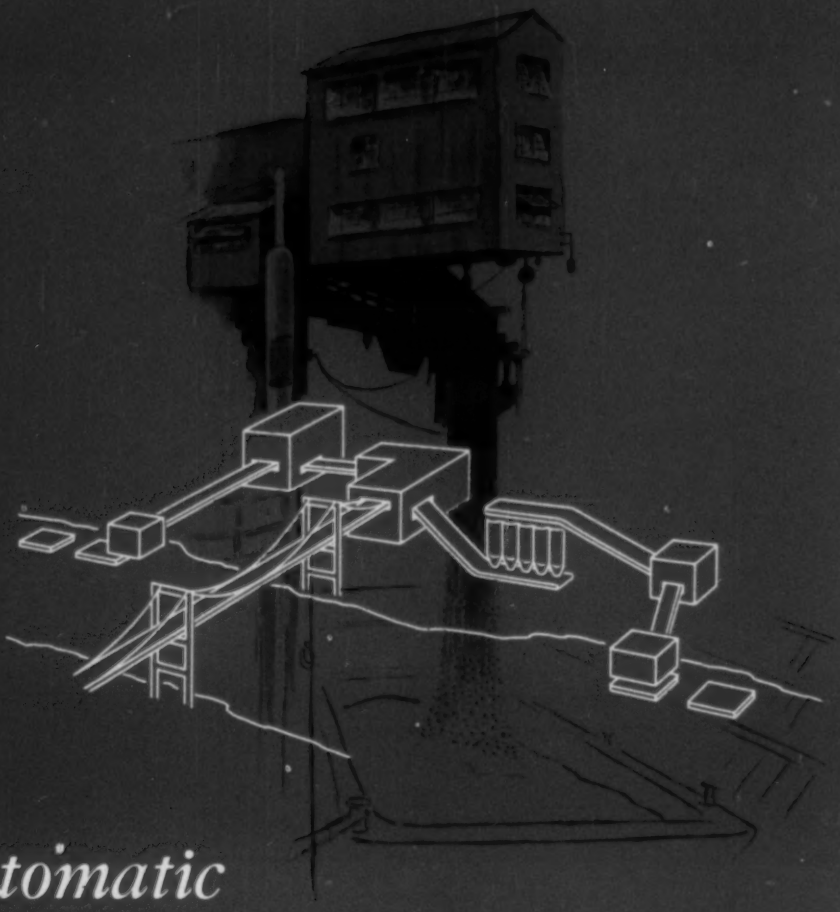
AUTOMATION

DECEMBER 1958



Automatic Proportioning System

The Magazine of Automatic Operations

- Data Input System Design
- Wire Inserting Machine
- Using Vibration Industrially
- Electrohydraulic Positioning System

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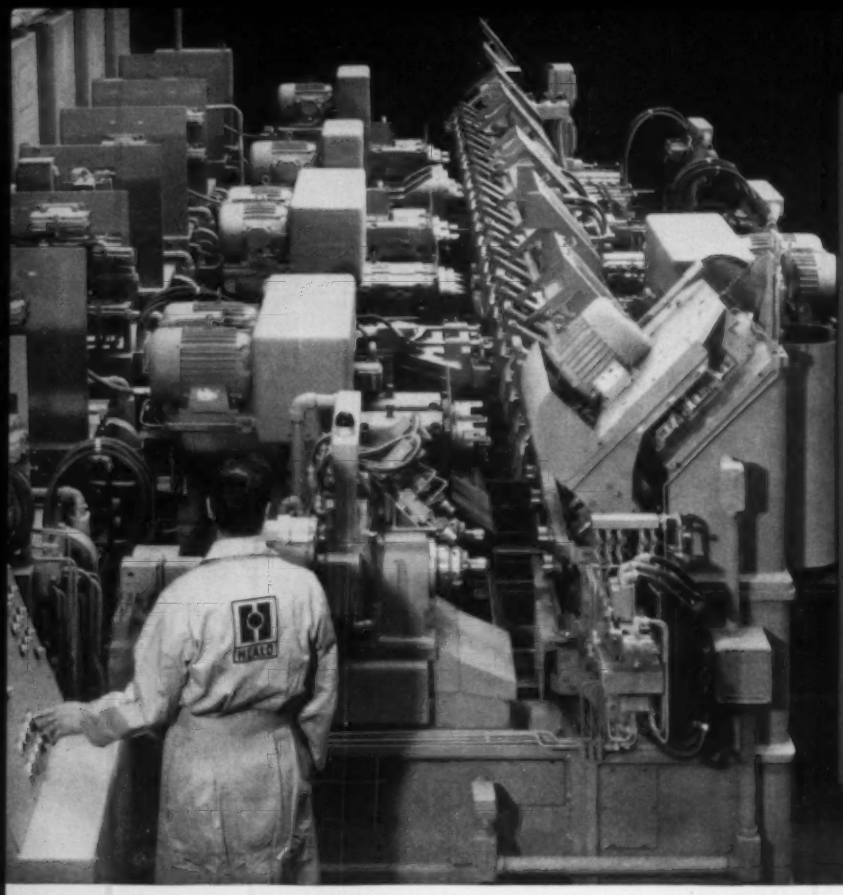

Here's Why BORE-MATIC VERSATILITY SAVES MONEY on Any Automated Production Line

When the time comes for a job changeover, you can do it at a saving with Heald Bore-Matics

Heald Slide Units Simplify Automation

The Heald *Slide-Unit* is the basic "building block" of an automated Bore-Matic production line. This simple, compact, hydraulically operated unit, complete with boringhead and drive, can be mounted in any position and can approach the work from any angle. It can be tooled for any desired operations—from roughing to precision finishing.

Because each Slide Unit is a separate and completely self-contained machine—arranged through interlocking control circuits to function as a fully automatic segment of the entire production line—individual machines can be added as required.

THE versatility of a Heald Bore-Matic has often been cited in terms of the machine's ability to perform a number of operations simultaneously. But this basic versatility has another advantage—one that is particularly important where large, automated equipment is involved. It *protects your investment* against the danger of early obsolescence!

For example, a Heald automated production line consists of the required number of *basically standard* Bore-Matics—tooled up to perform the required operations on a specific part. The machine becomes "special" only where part design requires it. Upon completion of the job for which the machine was designed, it can usually be re-tooled and put to work on a brand new operation—with a minimum of structural changes. This simplicity and economy of job changeover eliminates much of the "risk" in planning a long-term investment in automated equipment.

If you want a production line that's *protected against obsolescence*, talk to your Heald representative about Multi-Unit Bore-Matics, another example of why *It Pays To Come To Heald.*

HEALD®

THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.

Worcester 6, Massachusetts

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Circle 651 on Page 133

ANNOUNCING
the cylinder you designed!

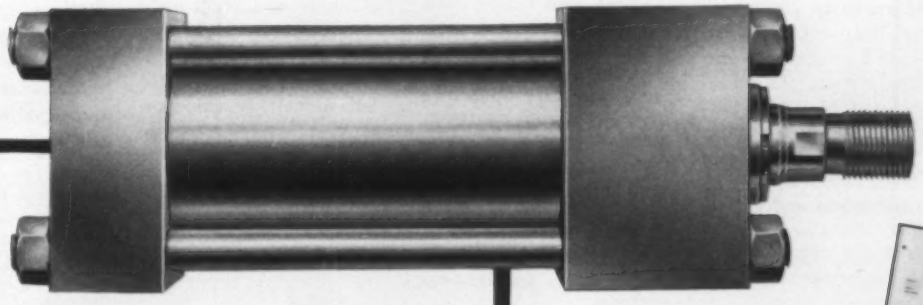
To save you and hundreds of other busy engineers time at the drawing board, Hanna representatives asked what you desired in hydraulic cylinder design.

You wanted a **stronger cylinder, preferably all steel with welded mountings.** You also wanted **tight sealing** at all pressures. These features were included in the Hanna Powrdraulic design. Some wanted **automotive piston rings;** others wanted **synthetic piston packings,** so the new flexible Powrdraulic design gives you a choice. You can also choose the **fast change cartridge gland** or the conventional **multiple lip packing** and you have a **choice of packing material** including Teflon* and silicone rubber.

Hydraulic cylinders should incorporate **industry standard mounting dimensions** and conform to Joint Industry Conference recommendations. These are included in the Powrdraulic design.

In addition, you want a cylinder that is **priced right,** with **prompt delivery** and **service available** in all parts of the country. You can have all this plus the assurance of quality when you specify Hanna Powrdraulic cylinders.

We will be happy to send you a catalog, and give you the name of your nearest Hanna Representative. You'll also find him listed in the yellow pages under "Cylinders" and in the alphabetical section of Thomas' Register.



Hanna Powrdraulic Hydraulic Cylinder
2000 psi and 3000 psi non shock — with generous factor of safety

Featuring — Pressure tightening tube seals
• One piece steel heads with welded mountings
• Double seal piston rings • Fast change cartridge gland
• Lubricated rod bearing

For full details write for Catalog 900

* Teflon is DuPont's registered trademark for its fluorocarbon resins.

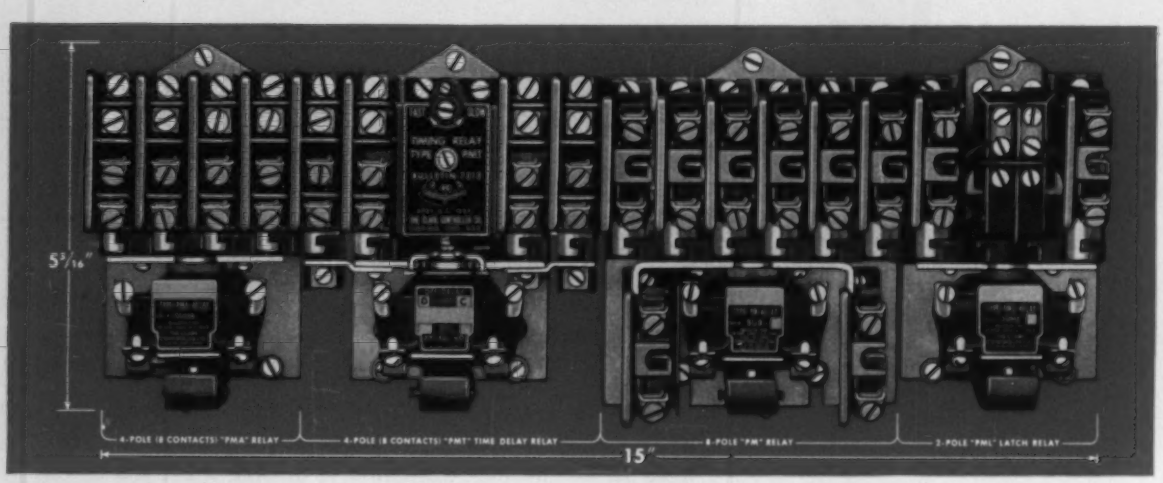
Hanna Engineering Works

HYDRAULIC & PNEUMATIC EQUIPMENT • CYLINDERS • VALVES

1753 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Circle 654 on Page 133

NOW CLARK OFFERS THE MOST COMPLETE INTEGRATED LINE OF CONTROL RELAYS AVAILABLE TODAY!



UNIVERSAL POLE RELAYS

up to 14 contacts per relay

New Clark Universal Pole Relays now double the available number of contacts per relay. Each universal pole contains two isolated contacts—one normally open, one normally closed. Melamine barriers and spacing provide 600-v clearance between contacts. Contacts have 10 ampere rating and wiping action. Universal poles are interchangeable with convertible poles of "PM" relays.

Line up with other Clark relays on a panel!

TIME DELAY RELAYS

2 or 4 timed contacts —up to 6 instantaneous contacts

New Clark Pneumatic Time-Delay Relays match physically other relays in the "PM" line. Timing head occupies the space of 2 poles above magnet. Universal poles each have isolated normally open and normally closed contacts, with 600-v clearance. Timed and instantaneous poles are identical. Available for "ON-DELAY" or "OFF-DELAY" operation (time delay after energization or de-energization), and easily convertible.

Line up with other Clark relays on a panel!

CONVERTIBLE POLE RELAYS

2 to 12 poles

The original line of space-saving control relays featuring exclusive Clark "modular construction". Revolutionary design provides 10 standard units with 2 to 12 poles, from 5 basic models. Stocking of relays and spare parts is greatly simplified. Poles are easily converted from normally open to normally closed and vice-versa. Individual poles are front removable without disturbing wiring.

Line up with other Clark relays on a panel!

LATCH RELAYS

2 to 10 poles

New Clark mechanically-held, latched-in relays have same modular design as "PM" relays—with latch unit occupying the space of two poles above magnet. No increase in height—saving panel space. Latch unit has its own continuous duty coil, allowing one more pole for circuit use since a relay pole is not needed to cut out coil when energized for sustained periods.

Line up with other Clark relays on a panel!

Detailed descriptive bulletins are available for all relays in the Clark "PM" line. Contact your nearest Clark sales office or write us direct.

The **CLARK CONTROLLER** *Company*

Everything Under Control

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DECEMBER 1958
Vol. 5 — No. 12

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

PREPARING MANAGEMENT REPORTS

". . . data processing systems, like manufacturing systems, involve a series of steps. Each step is complex and must be executed properly, if the end results—management reports—are to be worth anything. Just as it is necessary to build a product out of the correct raw material, it is necessary to build management reports from the correct input data. . ."—*Roger L. Sisson, Canning, Sisson & Associates,* *see page 40.*

CONTROL SYSTEM EVALUATION

". . . in its quest for greater productivity through automation, industry is demanding, and getting, electrical controls that provide the performance, reliability, and accuracy needed to regulate today's high-speed, multifunction machinery. As the complexity of this productive equipment increases, controls become more complex also . . . construction and thorough testing of prototype models may be the only way to establish the worth of a given control system. . . "—*R. A. Lorden, Industry Control Dept., General Electric Co.,* *see page 55.*

SMALLER WORK FORCE

". . . with a continuing rise in consumption and a greater share of the population remaining in school and retiring from active employment, those remaining in the work force will need the help of continual advancement in instrumentation and automatic control if they are to register greater output. . . " —*Henry B. duPont, vice president and director, E. I. duPont de Nemours & Co. Inc.*

IMPORTANCE OF RESEARCH

". . . continued investments of ample funds in carefully planned research projects can be an effective 'shot in the arm' during our present economic situation and at the same time provide the assurance of the further expansion of our economy. . . "—*Dr. Haldon A. Leedy, director, Armour Research Foundation.*

CROSS-FERTILIZATION IN HANDLING

" . . . remote control devices for handling of atomic materials have advanced so far that remote controls for manufacturing processes are only a question of time. The question is not 'if' but 'when'. Remote handling operations are a 'must' to the development of the nuclear industry. Methods have advanced greatly in the past few years. The adaptation of these methods to the remotely controlled, automatic factory is inevitable. . ."—*Walter J. Dollard, applications engineer, Atomic Power Dept., Westinghouse Electric Corp.*

FULFILLING A NEED

". . . many improvements are being made in computers, primarily in the area of solid state devices such as core memory, transistors, magnetic amplifiers, and others. I think this trend will continue for some time. However, I feel sure there will be a revolutionary change in computers when these devices can be reliably and economically assembled into a random access or 'real time' business computer. This would be a computer into which all business transactions of a business of significant size could be entered simultaneously and instantaneously as they occur. Also, the status of the business could be extracted on demand. . ."—*H. B. Hamilton, mgr., Operations Data Processing, General Electric Co.*

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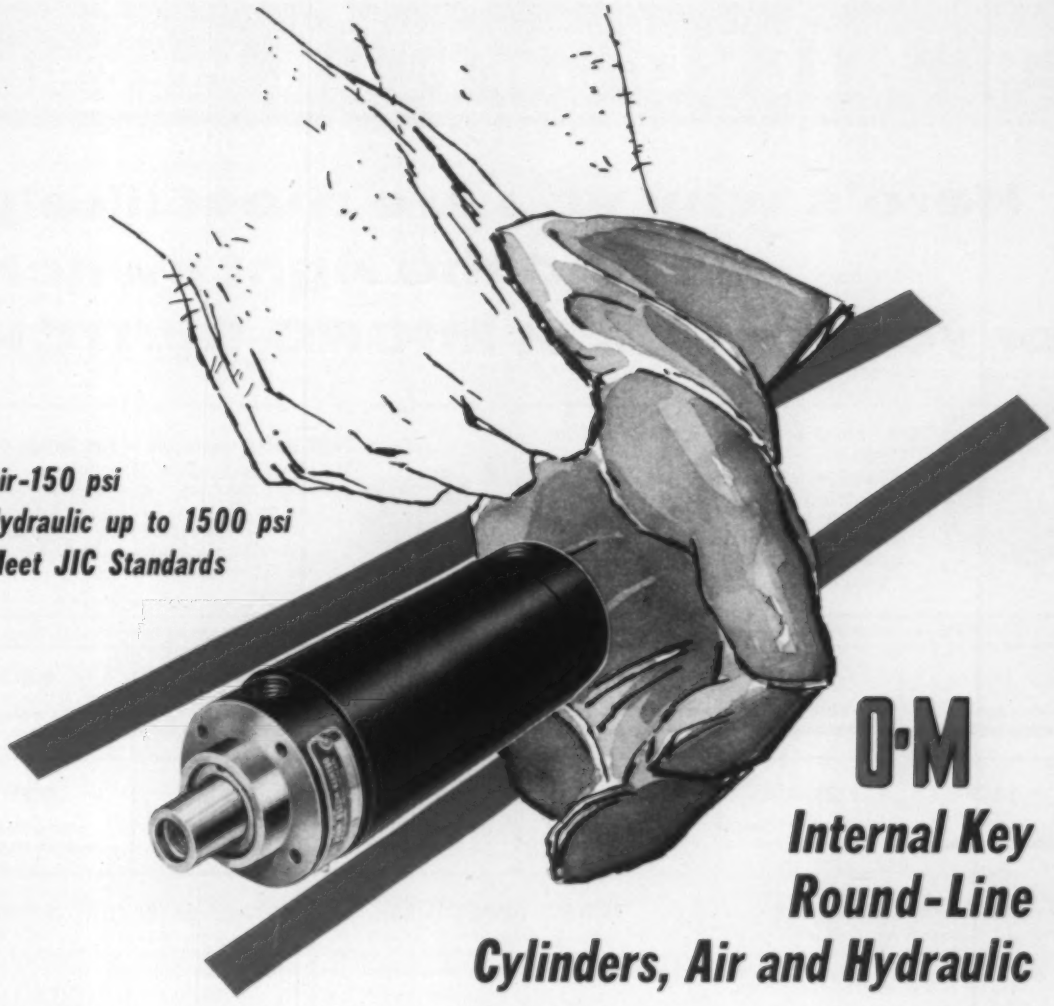


Air-150 psi
Hydraulic up to 1500 psi
Meet JIC Standards

O-M

Internal Key
Round-Line
Cylinders, Air and Hydraulic

Fit like a hand in a glove where space is limited

THAT'S why this O-M original Round-line of Cylinders, that fit where others won't, is widely specified by design engineers when space, weight and streamlining are important.

There are other advantages in using these powerful, compact components. For example, they are of all-steel construction with bearing surfaces of bronze, have the lowest coefficient of friction of any cylinder, and deliver continuous, smooth, dependable power at low or high speeds.

In addition, they are simple to install and service. The end plugs are tapped for universal mounting, and the ports can be oriented to any position. These cylinders are quickly and easily modified to fit special applications.

Available in a complete range of sizes (1½" to 8" bores) with standard 2 to 1 or oversize rods. Also full line of mounting brackets interchangeable bore for bore. Immediate delivery on many sizes.

Write today for catalog 101A.

ORTMAN MILLER MACHINE CO.
25 143rd Street, Hammond, Ind.

☐ Have representative call
☐ Send Bulletin 101A

Name_____ Position_____
Company_____
Address_____
City_____ Zone___ State_____

Circle 656 on Page 133

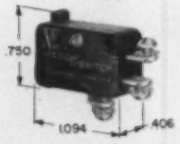
MICRO SWITCH Precision

Here's why you are most likely to find the right switch for your needs at MICRO SWITCH

Type "SM" basic switches — 259 variations

Subminiature in size, yet feature precision operation, long life, and high electrical capacity—up to 5 amps., 125 or 250 vac. Catalog 75 gives detailed information on "SM" subminiature switches, including actuators, housings, and assemblies.

Type "V3" basic switches — 198 variations

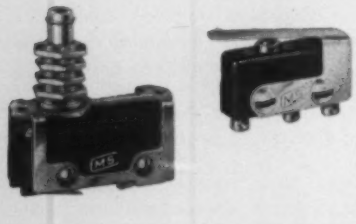


Combine extra compactness with high electrical capacity—up to 10 amps., 125 or 250 vac.—long life, and precise operation. Catalog 74 gives detailed information on "V3" switches and actuators.

The 259 variations are used in the following:			The 198 variations are used in the following:		
112 AUXILIARY ACTUATORS	**153** TOGGLE ASSEMBLIES	**42** ROTARY SELECTOR ASSEMBLIES	**88** AUXILIARY ACTUATORS	**71** TOGGLE ASSEMBLIES	**64** ROTARY SELECTOR ASSEMBLIES
129 METAL ENCLOSURES	**256** PUSHBUTTON ASSEMBLIES	**42** ALL OTHER ASSEMBLIES	**75** METAL ENCLOSURES	**3** PUSHBUTTON ASSEMBLIES	**77** ALL OTHER ASSEMBLIES

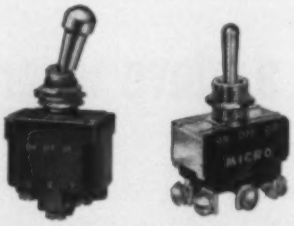
AUXILIARY ACTUATORS

Auxiliary actuators are used with basic switches, singly or in groups, to produce actuation from almost any direction or amount of force. Two examples are shown.



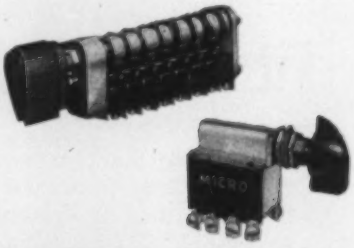
TOGGLE ASSEMBLIES

Many kinds of toggle switch actions are provided by a wide variety of toggle assemblies. Here are two examples.



ROTARY SELECTOR ASSEMBLIES

Precise sequential actuation of multiple-switch assemblies is provided by rotary selector assemblies like these.

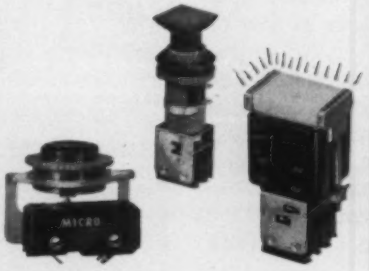


METAL ENCLOSURES

Metal enclosures provide protection from physical damage, sealing against harmful environments, means of mounting and conduit connections. Three examples are shown.

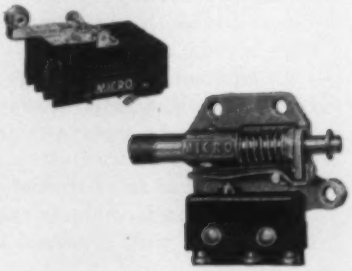
PUSHBUTTON ASSEMBLIES

Lighted pushbuttons, colored buttons, and assemblies for multiple switch operation are available for panel mounting. Here are three examples.



OTHER ASSEMBLIES

Other assemblies include door interlocks with automatic reset feature to assure safety, and single actuated dual mounted switch assemblies. Here are two examples.



Switches have uses unlimited

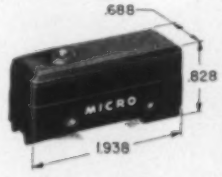
From just six of the basic switches in the MICRO SWITCH line come 7,577 different switches and assemblies . . . for use in machine tools, presses, machinery . . . computers, control panels, instruments . . . aircraft, missiles, launchers . . . to control and limit and guide almost everything in our modern electrical world.

The tabulation does not include our newest "baby"—the "SX"—shown here actual size.

Actual Size

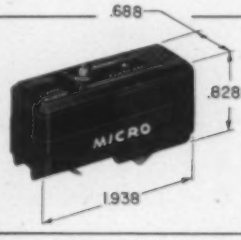
This is the first sub-subminiature, half the size of the famous "SM" subminiature, yet with 5 amp. capacity at 125 or 250 vac, long life and precision operation.

Nor does the tabulation include many basics for special applications, or mercury switches, of which there is a broad line.



Type "Z" basic switches—3,800 variations

Precise actuation and comparatively low operating force and motion. Up to 15 amps., 125, 250, 460 vac. Catalog 62.

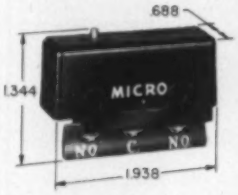


Type "A" basic switches—950 variations

Extra-high electrical capacity — 20 amps. steady state current; 75 amps. inrush current—at up to 460 vac. Catalog 62.

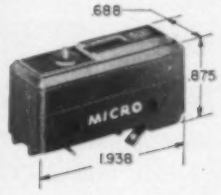
The 3,800 variations are used in the following:		
68 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
765 METAL ENCLOSURES	**16** PUSHBUTTON ASSEMBLIES	**14** ALL OTHER ASSEMBLIES

The 950 variations are used in the following:		
27 AUXILIARY ACTUATORS	**—** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
58 METAL ENCLOSURES	**14** PUSHBUTTON ASSEMBLIES	**16** ALL OTHER ASSEMBLIES



Type "DT" basic switches—78 variations

Highly compact double-pole double-throw switches, with marked terminals providing normally-open and normally-closed contact for each pole. 10 amps., 125 or 250 vac. Catalog 62.



Type "MT" basic switches—67 variations

Long life, high d-c capacity switches—10 amps., 125 vdc—when wired either "polarized" or "non-polarized". SPDT. Offer compact units for flexible control of motors, solenoids, etc. Catalog 62.

The 78 variations are used in the following:		
29 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
62 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**6** ALL OTHER ASSEMBLIES

The 67 variations are used in the following:		
7 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
11 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**1** ALL OTHER ASSEMBLIES

Experienced engineering assistance in switch application in your field is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages. For the right switch—and every switch right—look first to MICRO SWITCH.

MICRO SWITCH . . . FREEPORT, ILLINOIS
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Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle 657 on Page 133

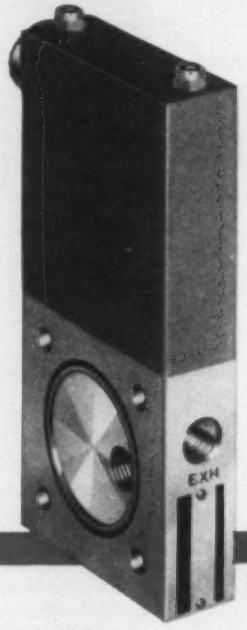
Introducing the new

HUNT

Slim Line

VALVES

SOLENOID, SINGLE PILOT
DOUBLE PILOT, LEVER
OR BALL ACTUATED



ONLY 1″ THICK BY 3″ WIDE

Compact, light in weight, and easily manifolded, these new Hunt valves have been designed specially for use when mounting space is limited. Ideally suited for controlling small cylinders, or to operate diaphragms, pilot cylinders or other devices. Pressures to 125 psi.

Proven, dependable Hunt construction, with hollow, radially ported stainless steel plunger; and "O"-ring seals accurately positioned with metal spacers, held rigidly in metal to metal end abutment. No lapped joints and no rubbing of metal against metal to cause wear, assuring long, efficient, maintenance-free operation.

Easily manifolded. The side of each valve is counterbored; trepanned for an "O"-ring and provided with four through holes. This permits up to eight valves to be manifolded together in any of four 90° angle positions, and operated simultaneously from a single supply;— or up to sixteen valves from two supply sources.

More startling HUNT designs to come!

Send for the "SLIM LINE" Bulletin No. 581 TODAY!

HUNT

Quick-As-Wink*® AIR AND HYDRAULIC CONTROL *Valves

Manufactured by HUNT VALVE COMPANY, 2072 East Pershing St., Salem, Ohio

Circle 658 on Page 133

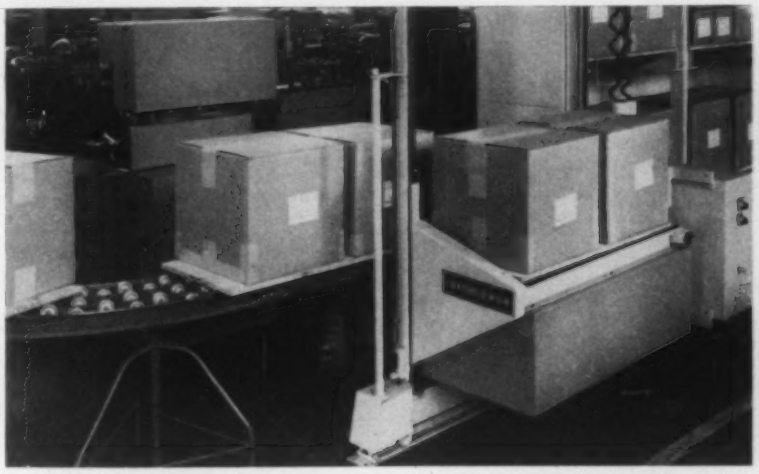
AUTOMATION news

Today's events and developments in the field of automation

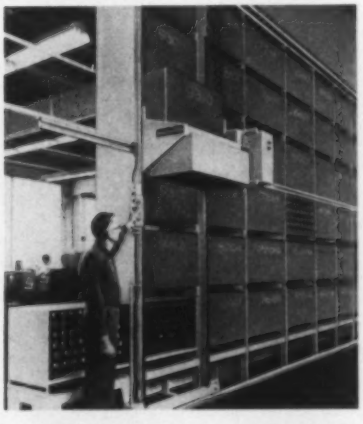
Mechanical Storage System Conserves Floor Space

STORAGE SPACE for raw materials, in-process products, or finished goods ready for shipment usually requires a large percentage of the gross floor space available in a manufacturing plant. In addition to the actual square feet of occupied storage area, space must be provided in aisles and access areas for traffic to and from the storage facilities. Triax Equipment, Cleveland, Ohio, has developed a new floor-to-ceiling storage system that provides automatic movement of material weighing up to 4000 pounds into a storage wall which utilizes maximum overhead storage space and reduces the necessity for large access aisles.

The mechanical storage system, called the Retriever, consists of an electrically-operated traveling carrier, steel storage compartments, and a compact loading-unloading transfer station. Materials to be stored can be delivered to the traveling carrier by conveyor, fork truck, or other materials handling means. The materials can be on skids or pallets, bins or trays, shipping containers, or any other storage device.



FLOOR-TO-CEILING storage system developed by Triax Equipment can pick up shipping boxes to be stored directly from a conveyor system. System features automatic storage and retrieval of various type units into and out of designated compartments. Maximum utilization of floor space and overhead air rights is accomplished by the space-saving system.



DIAL SYSTEMS, pushbuttons, or punched cards can be used to designate the compartment address in the storage system. Tiers of compartments or drawers can be added both horizontally and vertically to make greatest use of storage space.

The compartment address is first designated by an operator using a dial system, pushbutton keys, or punched cards. The carrier then picks up the load to be stored and transports it first horizontally and then vertically to the desired address in the storage wall. The load is automatically transferred into the storage compartment, and the carrier returns to its home position.

Retrieving a stored item is accomplished in a similar manner. The compartment address is designated, and the carrier automatically moves to the correct compartment, picks up the load, and returns to its home station. The carrier then automatically transfers the load to material removal means such as conveyors or trucks.

Tiers of compartments can be added horizontally or vertically to make the storage wall as long or as high as desired. In manufacturing areas, single or multiple vertical units can be fitted into a limited space adjacent to a machine operator. Dimensions of the compartments can be tailored to fit any size product, and dust-free drawers can be used to store products needing protection.

Automated Mining System Promotes Safety in Mines

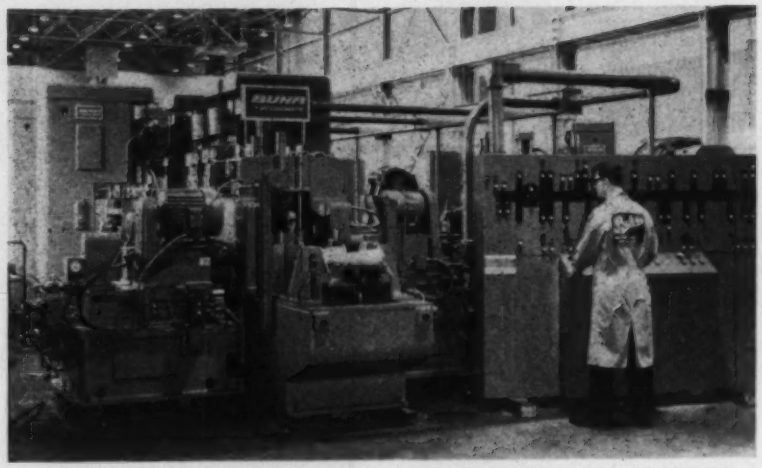
SYSTEM for strip mining high-wall coal seams from a surface control center has been developed by Union Carbide Olefins Co., Div.,

Union Carbide Corp. Joy Mfg. Co. has signed an agreement with Union Carbide for the right to manufacture, use, lease, and sell the new mining system. Major advantage of the new system is that it does not require men to be inside a mine.

The remotely controlled system is operated by a man at an electronic control center outside the mine who actuates a continuous mining machine inside the mine. The machine can penetrate high-wall coal to a depth of 1000 feet or more. Sensing elements on the machine electronically report to the operator outside the mine whether the machine is properly headed into the coal. With this information the outside operator remotely guides the machine to follow a coal seam.

The mining machine automatically loads coal onto a heavy duty continuous transport system that follows the machine into the mine and delivers the coal to an outside discharge station. This transportation system is designed to operate under conditions where local roof falls may occur.

A prototype mining machine has been operating for several months in mines of the Peabody Coal Co., St. Louis, Mo. It has proven capable of advancing in a seam of coal at a rate of more than 100 feet per hour. Joy Mfg. Co. is proceeding with the final commercial development of the mining system and plans to have the first machine in operation in approximately 18 months. Although the new system is primarily suited to high-wall strip mining, it might be made applicable to underground deep mines in five to ten years.



MACHINING OPERATIONS on rear extension housings for automotive transmissions are performed by two in-line transfer machines built by Buhr Machine Tool Co. Now in operation at the new Sharonville, Ohio, plant of Ford Motor Co., each transfer machine has 18 working heads which drill, ream, chamfer, tap, face, and bore the housings. Included in the transfer line are 6 probes and air gages for dimensional checking of the housings. When the line is fully loaded, 36 parts are in process, and a machined housing is discharged from the line every 21 seconds. Each machine is controlled by a General Electric Co. panel having 750 static logic units.

Automated Handling Speeds Banana Ship Unloading

HANDLING of bananas from ship to shore requires extreme care to prevent bruising and fast unloading to limit ripening. Four specially designed semigantry conveyor units are being erected at Baltimore, Md., to unload perishable bananas from refrigerated ships to refrigerated railroad cars or trucks as gently and as fast as possible. Designed by the George L. Day Co. Inc., the automated units will be able to unload 7 million pounds of bananas in nine hours from United Fruit Co. ships.

Each of the four semigantries has a main boom, an auxiliary boom, and a marine leg that reaches to the bottom of the ship's hold. The entire operation of each unloader is handled from the deck of the ship by one operator using a portable pendant pushbutton control. The units extend 80 feet into the air and use 36 electric motors, ranging from 1 to 15 hp, for operation. The four unloaders are mounted on rails and travel along the 400-foot pier length.

Balanced Program Planned For Third Automation Conference

TENTATIVE PROGRAM for the Third Conference On Manufacturing Automation to be held at Purdue University on March 23-25, 1959, has been established. This is the third technical conference on automation co-sponsored by the Schools of Mechanical Engineering and Industrial Engineering of Purdue University and the editors of AUTOMATION. Some of the subjects to be featured are: Developing automation for flexibility of output, cost analysis and machine replacement, assembling complex devices, automated handling for the small company, modern developments in control, and numerical control of production machines. Final details of the conference program will be announced early in 1959.

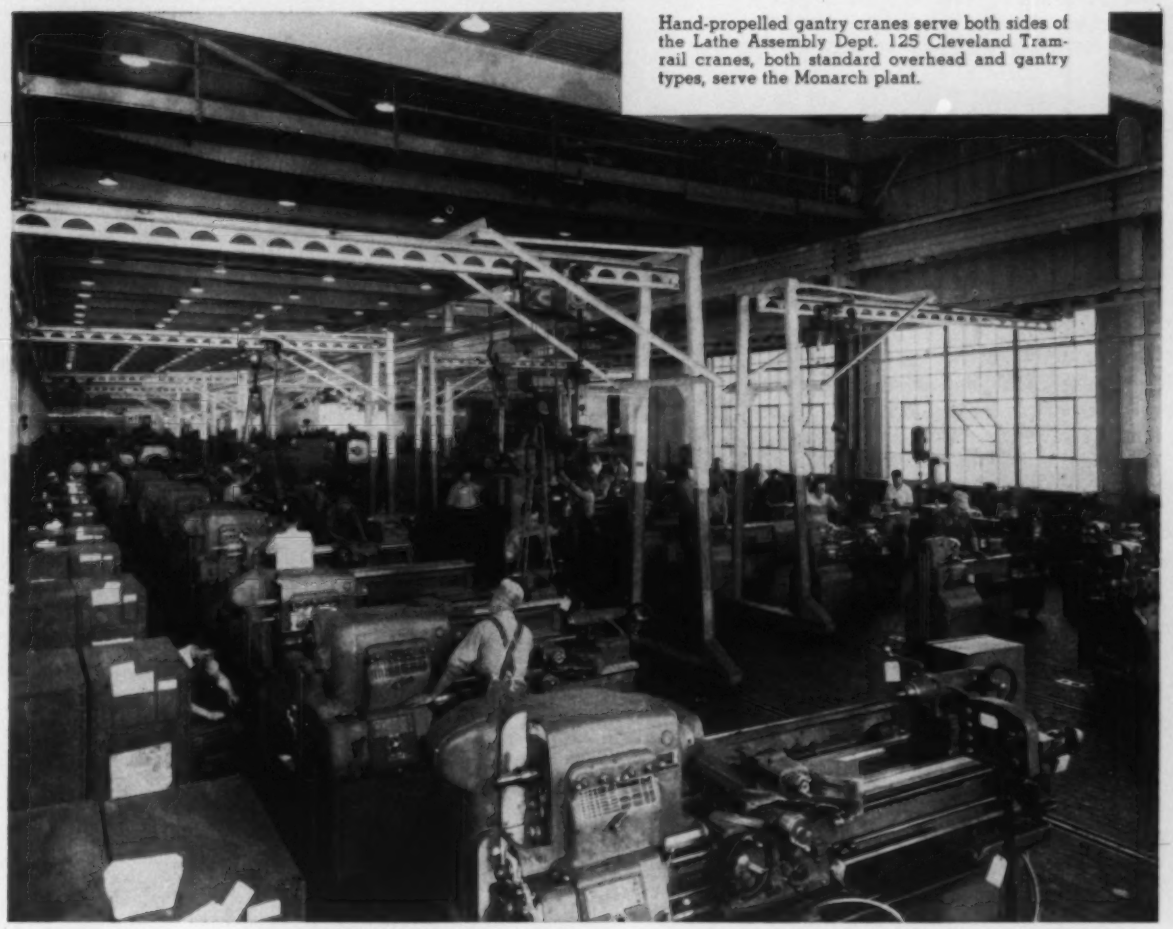
Flour Storage Facility Saves Bakeries Space and Money

BULK FLOUR storage facility is being built in Baltimore, Md., by the Process Machinery Div., Superior Separator Co., to serve as a terminal shipping point for bulk flour in the Baltimore-Washington area. The new terminal is the result of interest expressed by over 25 flour milling companies, and services of the facility will be equally available to all bakeries within 75 miles of Baltimore.

Bakeries in the area will have the flexibility of purchasing specific

SUBSTITUTES CRANES for BRAWN ...and BOOSTS LATHE PRODUCTION

One Crane for Every 6 Production Workers



Hand-propelled gantry cranes serve both sides of the Lathe Assembly Dept. 125 Cleveland Tramrail cranes, both standard overhead and gantry types, serve the Monarch plant.

EVERY manufacturer recognizes the need of mechanical handling equipment for hoisting and moving parts weighing hundreds of pounds, but not so many appreciate the value of cranes for handling parts that are within a man's ability to lift.

The Monarch Machine Tool Company, Sidney, Ohio, the world's largest exclusive manufacturer of lathes, made a thorough study of the effects of heavy manual lifting. They found that parts weighing only 50 or 75 pounds can be the cause of smashed fingers, hernias, and other injuries. When such parts must be handled numerous times a day, worker fatigue becomes a serious problem and affects not only production but workmanship.

Cleveland Tramrail cranes have proven to be the solution to the problem. For more than 15 years Monarch has been using Cleveland Tramrail equipment and today has 125 cranes of the standard overhead and gantry types which provide handling service throughout its fine modern plant. The importance attached to cranes here is attested by the fact that one crane is provided for every six production workers on the job at any one time.

WRITE FOR FREE COPY of Engineering and Data Booklet No. 2008. Packed with valuable information. Profusely illustrated.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

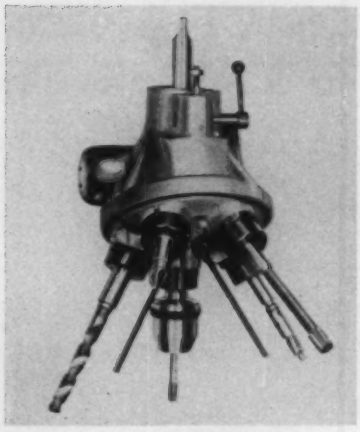
CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1322 E. 290 ST. • WICKLIFFE, OHIO

brands and types of flour from numerous flour mills who will use the terminal. This will enable the bakeries to reduce in-plant flour inventories, releasing dead storage space for manufacturing use. **R. E. Koester**, president of E. H. Koester Bakery, stated that the facility will enable his plant to cut a 3-week inventory of flour normally stored in the bakery to a 3-day supply. In addition to space savings, **W. P. Edmunds**, general manager of the Process Machinery Div., Superior Separator Co., estimated that bakeries will also save approximately 20 to 25 cents per cwt by using bulk flour instead of bagged flour.

The terminal will charge the mills a small fee for the actual amount of flour stored and handled. All marketing functions will remain with the individual mills using the facility. One of the unique features of the terminal will be a new truck loading device which will reduce flour loading time by over 50 per cent and keep cartage costs to a minimum. Flour will be delivered to each bakery by modern bulk trucks.

New Firm Formed by Merger

MERGER of the 5-year old Ramo-Wooldridge Corp. into Thompson Products Inc. has been announced. The agreement for the merger designates the name of the new combined company as Thompson Ramo Wooldridge Inc.



MULTISPINDLE drill head developed by Jersey Mfg. Co. provides a single spindle drill press with greater flexibility. Turret type head holds up to 5 tools which are automatically indexed by a self-contained motor. All spindles are quickly interchangeable, and eight independent spindle speeds are available. Unit will handle 1/8 to 1-inch drills and 1/8 to 15/16-inch taps.

The many divisions of the old Thompson Products Inc. will transfer to the new company with little change in title. The old company of Ramo-Wooldridge Inc. and one of its subsidiaries, Pacific Semiconductors Inc., will become divisions of the new firm. Space Technology Laboratories, a division of Ramo-Wooldridge Inc., will be set up as a separate subsidiary corporation with complete operational independence.

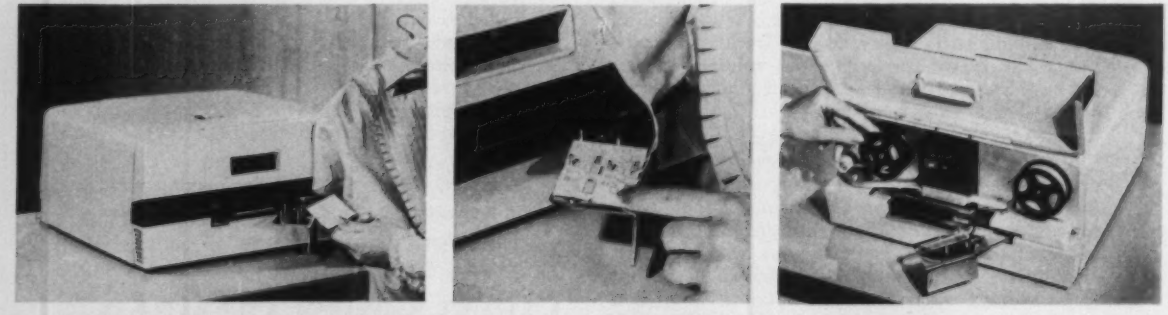
Thompson - Ramo - Wooldridge Products Co., a former subsidiary of both merged companies, will be operated as a division of the new company. This division specializes in industrial control and data reduction systems and is marketing a digital control computer for process control applications.

Control System Operates AC Motor At Variable Speed

GRINDING MACHINE control system developed by U. S. Electrical Motors Inc. increases the versatility of grinders and lengthens the life of grinding wheels. The system is unique in that it employs a standard 3-phase ac drive motor which is caused to operate at variable speed.

The control system operates by means of a simple electrical principle. The grinding wheel drive motor is used as a slave unit and is provided with a variable frequency ac current by a variable speed power unit. Since the speed of any ac constant speed motor is directly proportional to the frequency of the current it receives, variable speed is attained by varying the speed of the power unit.

The grinding wheel control system automatically compensates for wheel wear by increasing the rpm of the grinding wheel as the wheel diameter becomes smaller. In this way, surface speed of the wheel is kept constant. The system also is



MERCHANDISE CONTROL SYSTEM designed to provide a faster, more accurate record of the movement of goods has been announced by two firms—Minnesota Mining and Mfg. Co. and Automatic Records Inc. The system is one of the first utilizing portable equipment to record data by printed tape at the point of use or sale. The recorder, left picture, is a small, high speed unit which produces exact impressions of punched merchandise tags on a special paper tape. The tape is not punched, but is printed using the Thermo-Fax electric copying machine principle of Minnesota Mining. Recording of merchandise tags is a simple one-step operation requiring no operator training. The punched tags are placed on a swinging tray, center picture, and inserted into the machine. The hole pattern punched in the tag is then printed on 5/8-inch wide tape in less than a second. After as many as 600 tags have been recorded, the tape is removed from the recorder, right picture, and placed on a converter built by Automatic Records. The converter reads the printed impressions on the tape and automatically transmits the information to any standard key punch machine at a rate of 15 impressions per minute or a summary punch machine at a rate of 100 impressions per minute. The punched cards are sorted and tabulated, producing an itemized report of the data originally recorded.

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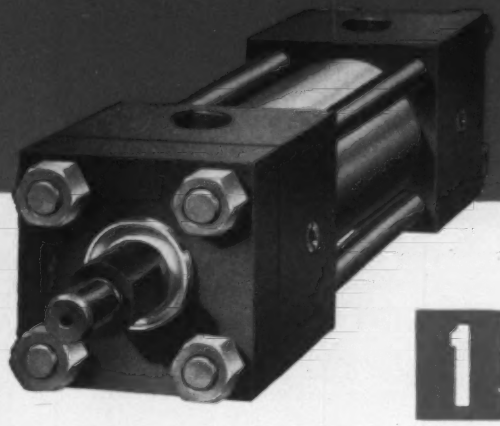
SEAL FAILURE MEANS CYLINDER FAILURE

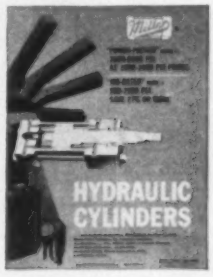
Petroleum base, fire-resistant and special hydraulic fluids cause distortion and rapid deterioration of the seals currently used in many hydraulic cylinders, resulting in costly repairs and cylinder failure. (Seals made of synthetic rubber are not compatible with even 50% of available commercial petroleum base fluids and the life of such seals is materially reduced at operating temperatures above 150° F.)

Specify Miller HYDRAULIC CYLINDERS

FOR UNLIMITED SEAL LIFE!



Request Bulletin JH-104N for complete data plus helpful charts on column strength, cylinder forces, factors of safety, acceleration, pipe pressure losses, etc.



1 ALL TEFLON* SEALED Against External Leakage

TEFLON is impervious to all known hydraulic fluids, including all fire-resistant and special types—and withstands temperatures from —100°F. to plus 450°F.

TEFLON SHEF SEAL AT TUBING ENDS

No blind assembly. Is

Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON SEALS ON PISTON ROD AND BUSHING

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON SEALS ON BALL CHECK AND ADJUSTING SCREW

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

2 CASE-HARDENED CHROME PLATED PISTON RODS

Provide foolproof protection against seal failures resulting from rod damage. The Miller case-hardened rods (50-54 Rockwell C) give practically complete immunity to damage from hammer blows, wrench-dropping, mishandling, etc. The hard chrome plating over the case-hardened rods protects against scratch-damage and rust.

AVAILABLE IN TWO TOP QUALITY LINES

JOB-RATED
Model "J"

PRICE SAVINGS OF 27% OR MORE!

19 mounting styles, all strokes, cushioned and non-cushioned. Large selection for immediate shipment.

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

POWER-PACKED
Model "H"

50% More Power Per Cylinder Dollar!

For

3,000-5,000 P.S.I.

1½" through 12" bores, 17 mounting styles, strokes up to 22 ft., cushioned and non-cushioned. Large selection for immediate delivery.

*DuPont trademark for its tetrafluoroethyline resin

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

- Solid Steel Heads, Caps and Mountings.
- Precision-Honed Barrels.
- Rust-Resistant Coating on All Non-Wearing Surfaces.
- Space-Saving "Square" Design.

MILLER FLUID POWER
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AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

used to increase or decrease the surface speed of the wheel due to variations in the hardness of metals being ground. By adjusting the speed of the power unit, the surface speed of the wheel may be changed to another constant value which will be held regardless of wheel wear.

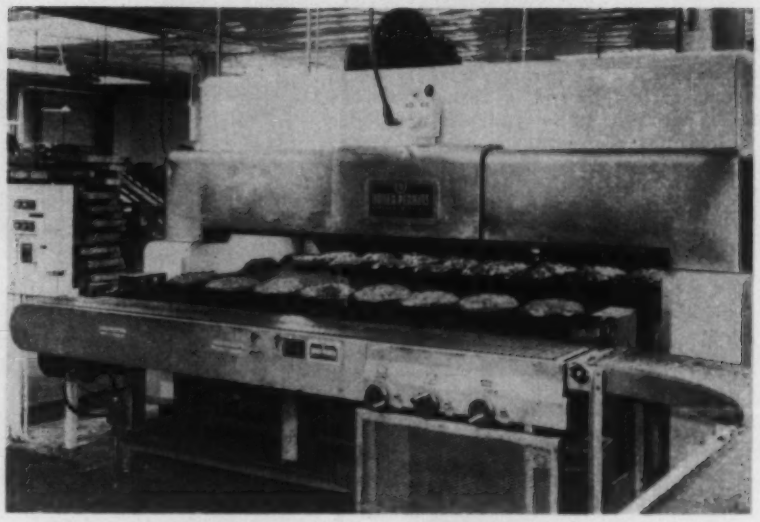
System Collects Data And Controls Remote Devices

DATA COLLECTION and control system, developed by Texas Instruments Inc. as a fluid level data collecting system, is now available for industrial uses requiring both data collection and remote control of ON-OFF devices. Utilizing serialized transmission of digital data and multiple verification checks to insure accuracy, the data-control system is applicable to most industrial monitoring and/or control processes where medium speed access is acceptable.

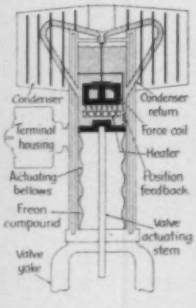
System is composed of a centrally located receiver unit, a remotely located field selector unit which can read and control 100 locations or be cascaded to control 1000 locations, an analog input unit for analog output transducers, and other necessary transducers and control elements. Connection between the receiver unit and field selector unit may be by direct wire, telephone, or radio using a digital code for accuracy and reliability.

Typical operation cycle is started by dialing a 2-digit station number. The field selector verifies the interrogated station and connects the transducer to the system. After the transducer output has been decoded at the receiver and three separate accuracy checks have been made, the data, station, and function identification are displayed on the receiver console and may be recorded by various types of data readout devices.

Either analog or digital output transducers may be employed in the system. Interrogation and control programs may be manual or automatic. Readout can be visual, printed, or fed directly to computers or data loggers. Semiconductor components are used in the system to increase reliability and minimize maintenance.



AUTOMATIC HANDLING of pies has lowered production costs approximately 20 per cent at California Pie Co., Brooklyn, N. Y. Engineered by Baker Perkins Inc., the installation features conveyor movement of pies to the entrance of a 60-foot tunnel oven, an automatic loader which moves a row of pies from the conveyor onto the oven hearth, a retractable pie filling machine which can be located over the entrance hearth for filling pastry shells, and an automatic unloading device on the exit end of the oven, shown above, which transfers a row of baked pies to a carry-away conveyor. The finished pies are then moved by conveyor to storage and packaging operations. The automated baking system can also be used for other items such as layer and pound cakes.



THERMO-DRIVE actuator developed by Swartwout Co. utilizes the expansive force of Freon vapor to position valves and other final control elements with precise and repeatable accuracy. The operating principle of the actuator is based on the controlled rate of heat release through a fluid medium, Freon, circulating in a closed chamber open only to a condenser. The gas is continuously vaporized by an integral heater and creates a vapor pressure within the chamber. Control action is achieved by varying the bleed rate of the Freon into the condenser through a release valve which is operated by a force coil responding to a command signal from a control instrument. When the bleed rate is decreased, the vapor pressure increases and compresses the bellows, causing a downstroke on the valve steam. An increase in the bleed rate permits the bellows to expand, producing an upstroke. Unit develops a force of 500 pounds (opposed by a 300-pound return spring force) and gives a total stroke length of 1.5 inches. Precise positioning of valve stem is assured by a built-in feedback loop.

Machine Tool Standardization Supported by Major Companies

BUILDING BLOCK or unitized design concept for production machine tools is winning widespread support from many manufacturing firms according to **Henry C. Daum**, manager, Machining Process Dept., Ford Motor Co. Daum is chairman of an industry study committee investigating the possibility of standardizing dimensions on building blocks that make up production machines.

Mr. Daum said that 15 companies have already endorsed the building block concept. These include the Ford Motor Co., General

Greenlee Transfer Machines can be Reworked to meet Product Changes

The Greenlee "Rearrangeable Unit" concept of transfer machine design is becoming increasingly popular in mass production manufacturing. These machines accommodate recurring changes in product design. Year after year they guard against costly obsolescence . . . they are changed to meet your changing requirements. Get the complete story from Greenlee.

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GREENLEE STANDARD AND SPECIAL MACHINES AND TOOLS

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- Six and Four-Spindle Automatic Bar Machines
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- Core Box Rollover and Draw Machines
- Specialized Woodworking Machines
- Hand Tools for Woodworking
- Tools for Woodworking Machines
- Hydraulic Tools for Electricians, Plumbers, Contractors

GREENLEE GUARDS AGAINST COSTLY OBSOLESCENCE

GREENLEE BROS. & CO.

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Motors Corp., Chrysler Corp., Waukesha Motor Co., Bendix Aviation Corp., International Harvester Co., Caterpillar Tractor Co., Allis-Chalmers Mfg. Co., American Motors Corp., Cummins Engine Co. Inc., Dana Corp., General Electric Co., International Business Machines Corp., White Motor Co., and Vickers Inc.

Manufacturers endorsing the building block program were unanimous in their opinion that the new type machine construction offered numerous advantages for reducing machine obsolescence. Mr. Daum said, "The so-called 'unitized automation' would encourage incorporation of technological advancements and product design changes which benefit the buying public since the flexibility of equipment will make the changes less costly. The building block concept also appears to be the answer to extending the automatic production line into new areas of industrial use, since purchase of the new equipment will be more economically practical for smaller companies."

One point emphasized was that industrial users are not attempting to dictate design features to machine tool builders since only a limited number of standardized specifications are being recommended. At the present time, some machine tool builders already produce machines with standard dimensions. However, each builder's standards are usually applicable to his own products. The committee is endeavoring to get all machine builders to standardize certain machine tool dimensions to provide interchangeability of different manufacturers' units on a production line.

Metal Coating Can Be Applied Prior To Machining Operations

METAL COATING which facilitates the production of precision parts by permitting the units to be coated prior to machining operations has been developed by J. Landau & Co. Inc. The new finish can be applied by dip or spray means, and then baked to provide a permanent, durable finish.

Greatest use for the finish will be on parts that are difficult to coat after machining. Products can be first permanently coated with the material and then be precision ground, milled, turned, lapped, or otherwise machined without harm to the surface coating. The coating will also withstand degreasing and cleansing under high temperatures and applications of pressure and heat used in manufacturing operations.

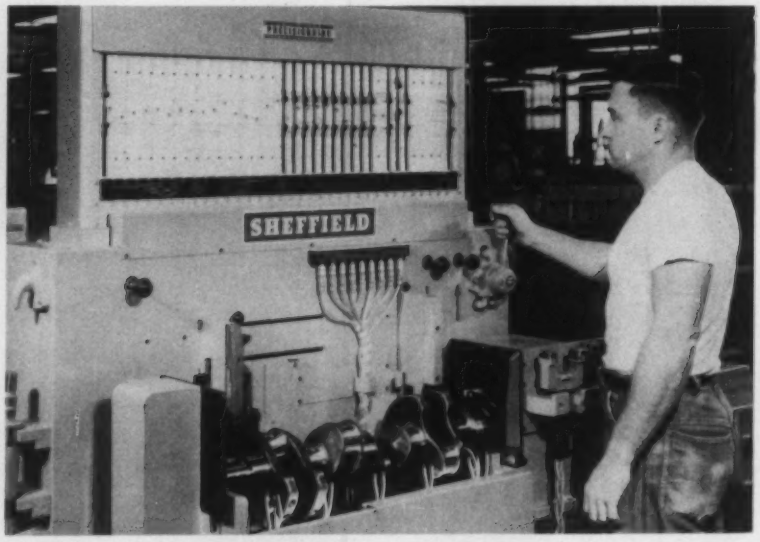
Punched Tape Used To Control Electronic Typesetting Machine

ELECTRONIC TYPESETTING machine capable of preparing metal type more than three times as fast as conventional methods has been developed by Dow Jones & Co., publishers of *The Wall Street Journal*. Radio Corp. of America will produce and market the new machine along with other RCA developed devices designed to help produce newspapers, periodicals, and other printed matter more efficiently and economically.

Electronic typesetters have been in use in printing plants of *The Wall Street Journal* for more than five years. The machines make possible the simultaneous publication of the national newspapers—identical in news and editorial content—from plants in New York, Washington, Chicago, Dallas, and San Francisco.

Operation of the typesetting machine is controlled by punched tape. A tape reading device audits the tape, and, according to the arrangement of the perforations, transmits electrical signals to a mechanism which releases the character to be set from a type magazine. When a sufficient number of characters have been selected to complete a line of type, a signal punched into the tape instructs the machine to cast the characters into a line of lead type.

The electronic typesetter is the first practical approach to a type casting machine designed primarily to operate automatically. Previous automatic operation of type casting machines utilized equipment built for manual operation. Basically, all such devices functioned by substituting either electrical or mechanical devices for an operator's fingers in tapping a type setting



MULTIDIMENSION GAGE designed and built by the Sheffield Corp. is used by a truck manufacturer to inspect three different sizes of diesel crankshafts, each having as many as 47 dimensions and conditions requiring inspection. Floats in the 34 column instrument panel instantly show out-of-tolerance dimensions at various points on the crankshaft during the gaging cycle. Typical dimensions and conditions checked include five main bearing diameters for taper, out-of-roundness, and size; thrust bearing width; pulley fit diameter; oil seal diameter; pilot hole diameter; concavity or convexity of end face; stroke radius of four pin throws; location of keyway to pin bearing, concentricity of pilot hole and flywheel pilot diameters; and diameter of the radius of the counterweights. Previous gages were limited to the inspection of a single crankshaft size.

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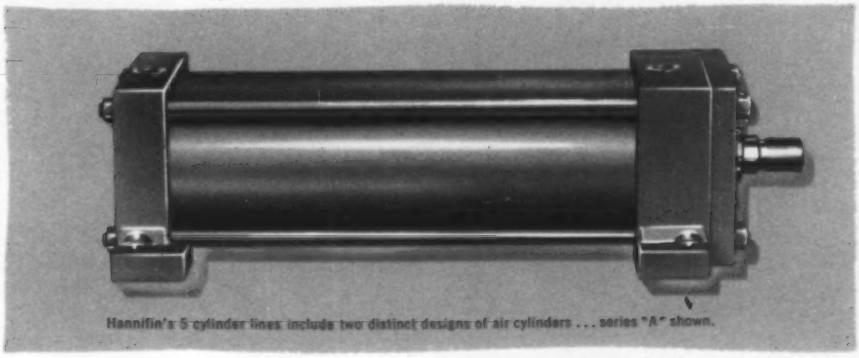
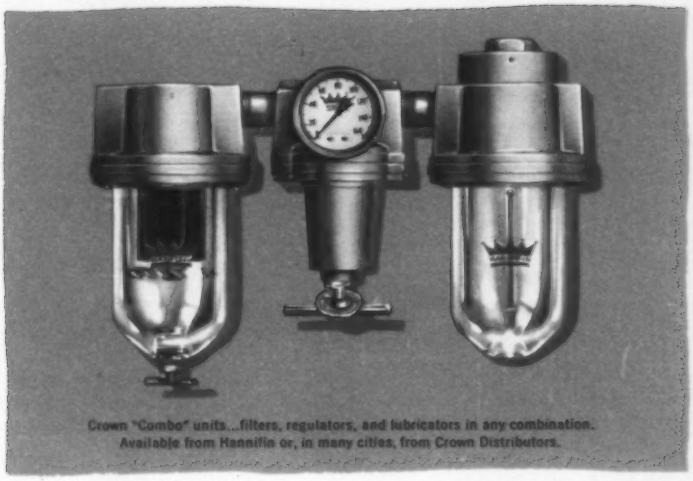
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

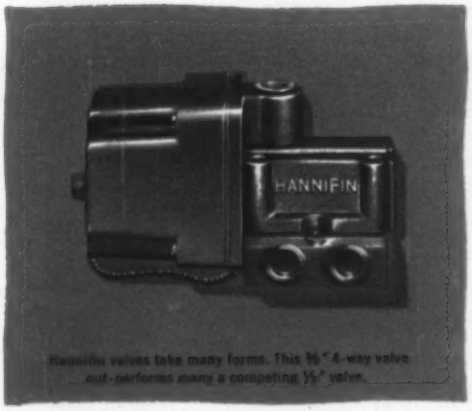


Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only **HANNIFIN** makes all these **AIR POWER COMPONENTS**



Hannifin valves take many forms. This ⅜" 4-way valve out-performs many a competing ½" valve.

Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

HANNIFIN COMPANY

505 South Wolf Road • Des Plaines, Illinois

A DIVISION OF PARKER-HANNIFIN CORPORATION

machine's keyboard.

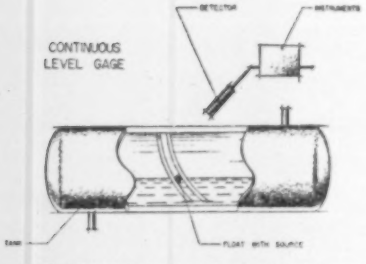
RCA has also formed a new Automation Products Dept. under the direction of **D. A. Thomas** with full engineering, production, and marketing facilities. The department will develop and market all types of newspaper automation equipment and RCA's present line of materials handling equipment, metal grinder controls, and electronic inspection units for beverages, foodstuffs, metal products, and plastics.

Expands Electronic Control Line

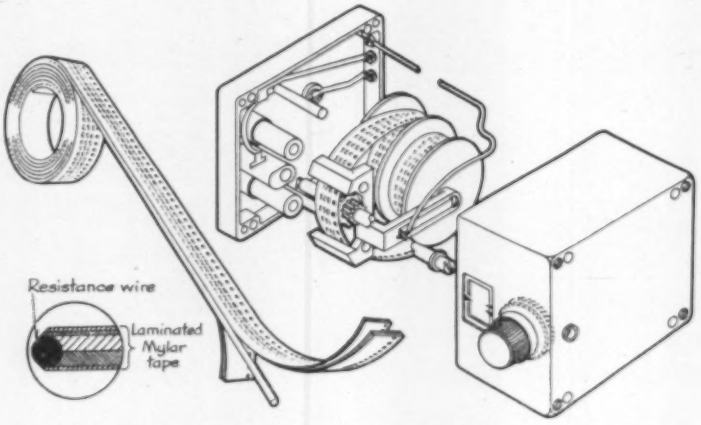
ADDITION of a line of photoelectric and other electronic devices for control, safety, counting, and measuring applications has been announced by Clark Controller Co. Included in the line are light-sensitive and resistance-sensitive relays and devices for temperature and torque measurement, counting, smoke detection, and personnel and equipment protection. The products were formerly manufactured and marketed by Electronic Controls Corp. who will continue to make the devices for Clark Controller Co.

Adds Packaging Machine Line

ACQUISITION of all design, manufacturing, and sales rights to the line of Packmaster automatic packaging machinery has been announced by Sundstrand Machine Tool Co. Machines in the line are capable of making flat-type and dome-type enclosures for hardware, strip trim, spare parts, and similar items. Either single or multiple items can be packaged with the equipment, and hopper feed units are available where required. Auxiliary functions, such as counting and printing, are performed by optional accessory equipment. The machines will be built and sold through the American Broach Div., Sundstrand Machine Tool Co.



CONTINUOUS level gage developed by Radiation Counter Laboratories Inc. measures liquid level in enclosed containers. Radioactive source contained in a float follows the level of liquid along a guide track inside the tank. Changes in the liquid level cause changes in the strength of radioactivity and are detected by a scintillation sensor located outside the tank. Radioactivity measurement is then calibrated to provide continuous reading of depth or volume of liquid.



SLIDEWIRE-TAPE potentiometer with direct digital readout for linear and nonlinear functions has been developed by the Howell Instrument Co. Basic active element of the unit is a resistance wire bonded within the edge of a laminated Mylar tape. Resistance wire may be either straight or in helical form, depending on the total resistance required, and is available in ranges from 100 to 100,000 ohms. During calibration of tape from a master tape, true digital resistance values are automatically printed along the face of the 120-inch tape. Readout is direct through a window on the front of the case. Any linear or nonlinear calibration is obtainable including direct digital reading of temperature with any type of thermocouple, square root extraction when used with differential pressure transducers for flow measurement, and hyperbolic and logarithmic functions encountered in analysis and radiation systems.

Electronic Controller Provides Precise Temperature Control

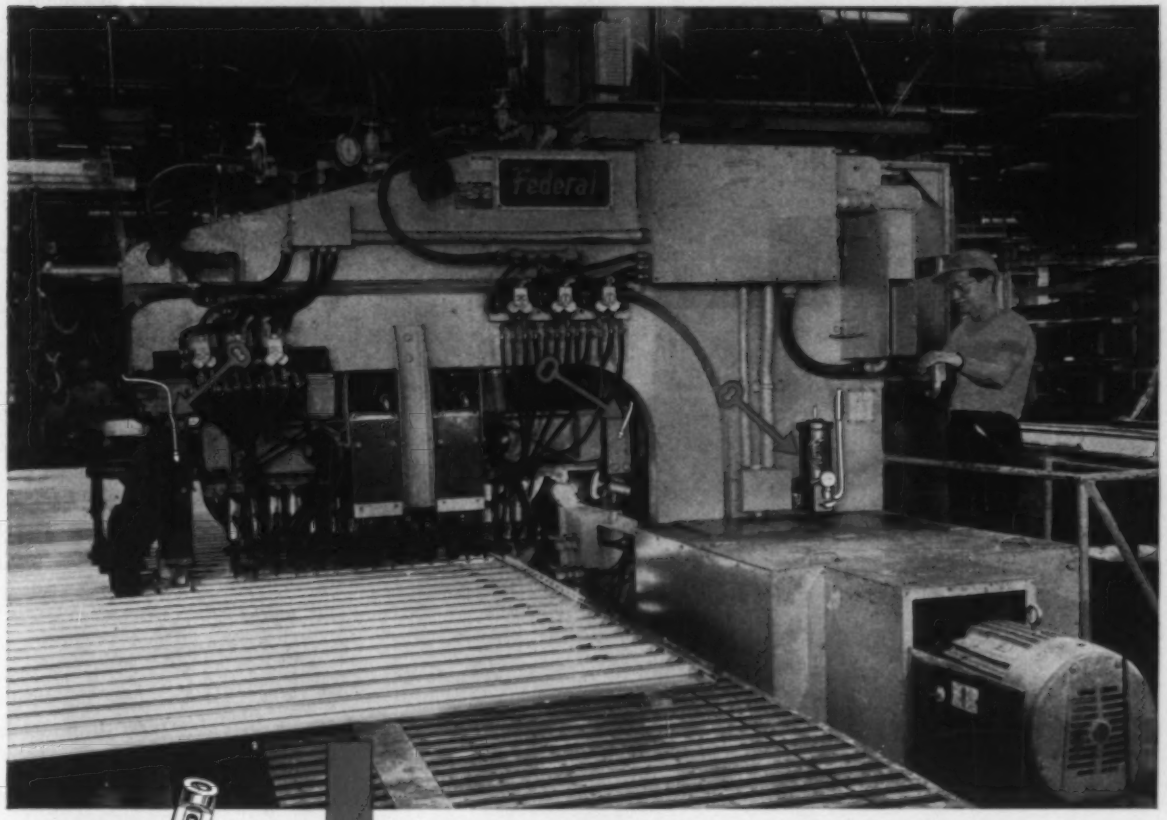
ULTRASENSITIVE electronic temperature controller which is responsive to thermocouple output fluctuations of 0.000001 volt has been developed by Hagan Chemicals & Controls Inc.

Applicable to all types of electric heat treating furnaces as well as laboratory test ovens, the controller is particularly useful in precise temperature applications where either the heater or the product temperature can change rapidly. For example, in glass fiber drawing, the electronic controller is capable of limiting die temperature fluctuation to less than 0.25 F despite process temperatures of 2200 F and constant changes in thread velocity and heating element load.

The controller employs a proportional amplifier for initial amplification of the thermocouple signal and uses magnetic amplifiers for summing and integration. Automatic and manual control of the process is provided with adjustments for proportional band, reset, and rate action to meet process requirements. A range selector allows manual switching for three temperature ranges which are 0 to 800 F, 800 to 1800 F, and 1800 to 2800 F.

SPOTLIGHTING PEOPLE

F. B. Wilkinson elected president of Logansport Machine Co. Inc. . . . **Edward A. Farwig** appointed manager of proposals, pricing, and orders at Buhr Machine Tool Co. . . . **Stanley Schneider** appointed manager of engineering for the Helipot Div., Beckman Instruments Inc. . . . **Joseph T. Bailey** named general manager of the General Purpose Control Dept., General



FARVAL—Studies in Centralized Lubrication No. 230

Farval lubrication system protects bearings on Federal multi-gun welder

Resistance welders such as this multi-gun Federal, owe much of their effectiveness to their ability to adjust vertical movement of electrodes within exacting limits. Chosen to guard the essential bearings which give this Federal welder its precise control is a modern Farval lubrication system.

Across the country, Farval systems have dependably extended bearing life on all types of metalworking machinery . . . some for as long as 30 trouble-free years. That's because any Farval system —automatic or manually controlled—*insures* that measured amounts of lubricant are delivered to every desired point at *predetermined* intervals.

Let a Farval lubrication system help you extend vital bearing life. Ask for revised Bulletin 26-S. Write The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

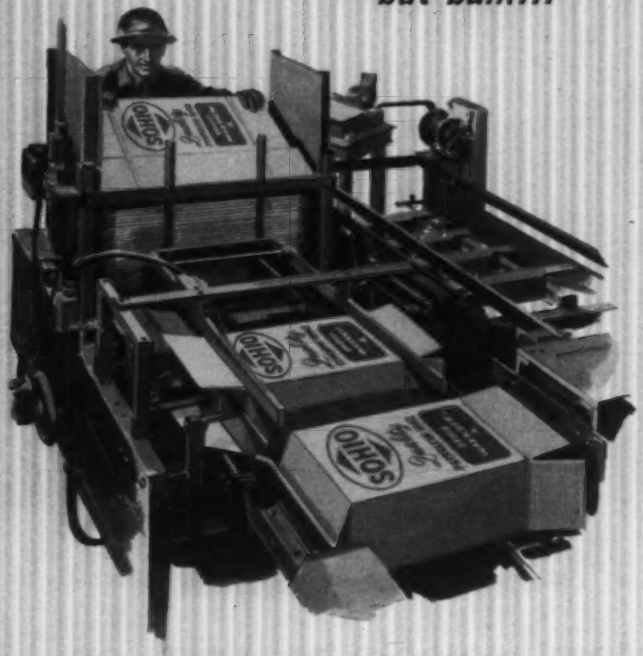
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval —familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.

Circle 663 on Page 133

These boxes do everything but balk...



H & D corrugated boxes for shipping Sohio wax start through this machine knocked down. They're set up, packed and sealed—automatically. Would precision packaging speed up your operations? Better see H & D.

HINDE & DAUCH

Division of West Virginia Pulp and Paper Company

AUTHORITY ON PACKAGING • SANDUSKY, OHIO
15 FACTORIES • 42 SALES OFFICES

LIQUID NITROGEN generator system offered by Arthur D. Little Inc. provides a complete nitrogen liquefying facility for industrial and laboratory users who have moderate demands for this product. Major components include an ADL nitrogen column, a modified North American Philips Co. Inc. gas liquefier, and a 200-liter storage tank. The system automatically provides up to 95 liters daily of 99.5 per cent pure liquid nitrogen.

Electric Co. . . . **Gordon M. Sommer** named vice president in charge of engineering for Clearing Machine Corp. . . . **Jack Rosenberg** appointed manager of engineering for Electronic Control Systems, a facility of Electronics Div., Stromberg - Carlson . . . **Clarence A. Wetherill** appointed chief engineer and **Roy C. Ritchart** named assistant chief engineer of Stromberg-Carlson—San Diego . . . **Carey A. Evans** appointed manager of engineering for the Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp. . . . **Seldon T. Williams** elected president and general manager of Scovill Mfg. Co., and **Garvin A. Drew** appointed general manager of the Schrader Div. of the same company . . . **D. R. Greenberg** named chief development engineer of Control Instrument Co., subsidiary of Burroughs Corp. . . . **Raymond W. Heimsoth** elected president of the Ess Instrument Co. . . . **George Gumas** appointed vice president in charge of engineering at CDC Control Services Inc. . . . **J. Henry Richmond**, president of Potdevin Machine Co., elected president of the Packaging Machinery Manufacturers Institute Inc. . . . **H. W. Alyea** named director of engineering, **W. P. Chapman** appointed director of research and development, and **John C. Spangler** named director of manufacturing at Johnson Service Co. . . . **Roger L. Sisson**

appointed manager of the systems department in the Tactical Operations Central Project of the Computer Div., Aeronutronic Systems Inc., subsidiary of Ford Motor Co. . . . **Frank Colonnese** appointed superintendent of the Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. . . . **Marvin E. Waspe** named plant manager of the Cincinnati Div., Bendix Aviation Corp. . . . **Peter H. Morganson** appointed assistant chief engineer of Veeder-Root Inc. . . . **William D. Fritz** joined Datex Corp. as senior mechanical engineer in charge of the Instrument Development Section . . . **J. Philip Evans** appointed to head the newly-formed Automation Research and Development Div., Harry F. Ortlip Co.

SPOTLIGHTING PRODUCTS

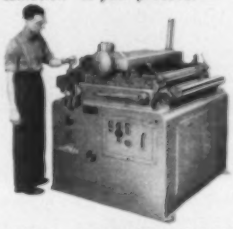
Linear variable differential transformer having a null position at one end of its core travel instead of at the midpoint has been developed by Schaevitz Engineering. The new construction technique of using only one side of the null point makes it possible to obtain a single-ended range which is approximately twice that of conventional dif-

SCALE MODELS of Elgin Metalformers Corp.'s modular enclosure system provide a 3-dimensional design aid for engineers. The miniatures, modeled on a one-inch to one-foot scale, are exact duplicates of full-size metal cabinets which can be combined in enclosure systems to house electronics equipment. Each basic module in the cabinet system is based on the universally used 19-inch panel width. Installation of the cabinet system is accomplished by joining preformed frames from a selection of over 100 basic designs with standard front, side, and back panels to make vertical or sloped front cabinets of varying heights and depths.

LITTELL

FEEDING-STRAIGHTENING MACHINES

HYDRAULIC RACK AND PINION FEEDING-STRAIGHTENERS, No. 4 HRP Series. 5-roll straightener and hydraulic drive for extra smooth, accurate feeding. Built in three sizes for stock up to .125" thick and maximum widths of 12", 18" and 24" respectively. Standard 19" feed length can be double cycled up to 38". Easily moved about to give "detachable automation" to your presses.



SINGLE RACK AND PINION FEEDING-STRAIGHTENERS, No. 4 Series machines with 3 to 1 Variable Speed Drive have 7-roll straightener and handle stock up to .062" thick. Built in 3 sizes for maximum stock widths of 24", 30" and 38". Feed 38" per cycle with normal feeding speed of 35 strokes per minute.

No. 6 Series machines have 5-straightener rolls, all power driven through a 3 to 1 Reeves Variable Speed Transmission. 4 sizes of these machines handle stock widths up to 36", 48", 60" and 78" respectively and feed up to 72" lengths per cycle. Quick Change Gears, block lubrication and air operated roll release available on all models, standard on most.

F. J. LITTELL MACHINE CO.

4105 N. Ravenswood Ave.
Chicago 13, Illinois
District Offices: Detroit, Cleveland

AUTOMATE

THE PRESS FROM ANY ANGLE

By a single electrical connection, the straightening-feeding cycle of these self-powered Littell machines is synchronized with the stamping cycle of your press. They feed the press or shear accurately from any direction, right to left or front to back. They can be positioned at odd angles to produce odd-shaped parts. They handle a wide range of stock widths and thicknesses. They can be disconnected from your press at will. The smaller machines are easily moved from press to press by fork truck, or temporarily set aside if a job is to be hand fed. Full details on these flexible press feeding machines is available in catalog sections "B".

DELIVERY IS GOOD

From the *larger* Littell plant, equipped to speed production.

LOOK TO LITTELL FOR ROLL FEEDS • SHEETING LINES
STRAIGHTENING AND FEEDING MACHINES
REELS AND CRADLES FOR COIL STOCK

SEE OUR CATALOG IN SWEET'S

USE THIS COUPON TO GET FREE CATALOGS.

F. J. Littell Machine Co., 4105 Ravenswood, Chicago 13, Ill.
Send Littell Straightener Catalogs "B"

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RIVETING REVOLUTIONIZED by the PAR PROCESS!

PAR ... **Originated by TRS** with the invaluable collaboration of some of industry's top production engineers who sought a major break-through in the automation of assembly operations to reduce costs.

PAR ... **A name given by TRS to its Production Automated Riveting process** ... continuously developed and perfected for 3 years. Proved successful in some of industry's most efficient plants. Now, TRS has sufficient engineers especially trained in the PAR process to serve all manufacturers.

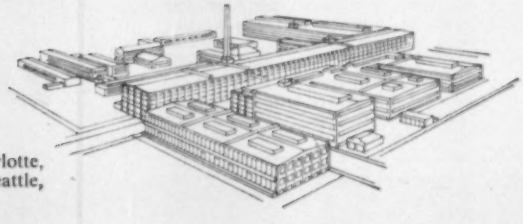
PAR ... **It makes riveting practically a new fastening method through efficiently integrated and automatic ...**

1. FEEDING of tubular rivets or related products.
2. TRANSFER of parts between riveter stations by means of sliding or rotating fixtures or dial tables. Or through synchronization with conveyors.
3. SEQUENCING the operation of from 3 to 15 rivet setters which make all fastenings simultaneously or in any desired sequence.
4. CONTROL of setting force as required by parts thickness or material characteristics.
5. SENSING of improper conditions and stopping equipment to avoid injury to parts, equipment or operator.
6. EJECTION of parts as required.

TRS®

TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASS.



Midwest Office & Warehouse in Chicago. *Branches:* Atlanta, Buffalo, Charlotte, Dallas, Detroit, Indianapolis, Los Angeles, New York City, Philadelphia, Seattle, St. Louis. *See "Yellow Pages" for phone numbers.*

FORD

almost tripled production —without adding to payroll

Ford engineers wanted to step-up the production rate on a window gear and cam assembly. They called in TRS engineers.

Here is the remarkable automatic TRS Machine that resulted. Because center distances would not permit employment of a Multi-Head Riveter, a triple drive machine was adapted by TRS engineers. This eight dial station set-up receives a gear and cam assembly . . . greases it . . . receives a shaft and housing . . . sets three rivets to fasten shaft and housing to the gear and cam unit . . . ejects complete assembly. The machine does everything but load the parts. Ford Motor Company know-how shows in the profitable solution . . . so does TRS ingenuity and experience.

You get the benefit of TRS "recognized ability" when you buy any TRS Riveting Machine . . . from the simplest, standard type to a complicated special design.

TRS offers more machines, to more exactly meet your need . . . will lease but likes to sell . . . guarantees performance and sticks by you with all-out service.

PAR . . . It's a TRS Process for very good reasons!

Obviously, there are two critical elements in the PAR Process. Essential is the special and extensive knowledge and experience needed to design an integrated system of standard or multi-head riveters, feeders, transfers and controls for the particular assembly involved. Equally important are superior knowledge and experience in the design, tooling and application of Multi-Head Riveters because these are usually employed.

TRS originated Multi-Head Riveters over three years ago and is the only experienced source of these machines. Further, because this TRS development opened up new possibilities for automating the riveting process, TRS was able to begin three years ago to develop the special experience and application engineers required to fully meet the requirements of the PAR Process.

PAR . . . A New Opportunity to Reduce Direct Labor Charges

With this new help, hundreds of manufacturers . . . large and small . . . can effect substantial savings in direct labor charges, increase production rates, decrease parts spoilage and machine down-time. Look into it now if your product can be riveted, and especially if several rivets are involved.

The yearly amortized cost of the TRS Multi-Head Riveter equipment is low because it will not be obsoleted by changes in product design or production line.

To save more . . . To protect against equipment obsolesence . . . don't buy any Riveting Machines until you investigate the PAR Process

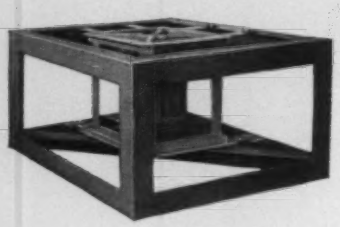
You're not required to use TRS Rivets but you'll be better off if you do

There are no contracts or obligations involved in the PAR Process. However, it is true that the more automatic you make your riveting, the more important it is to use rivets that reduce operating troubles and machine down-time. And, we can give you good, factual reasons why TRS Tubular Rivets are more reliable in essential qualities and uniformity. Ask for the facts . . . judge for yourself.

Advt. Copyright by Tubular Rivet & Stud Company, 1958

eccentric loading, side thrusts, pile-ups won't affect the accuracy of

THE W-C UNI-FORCE PLATFORM SCALE



No matter where or how the load falls, the Uni-Force Scale will deliver a true measurement of weight. Reason for this remarkable performance is the W-C flexural frame arrangement which resolves platform thrusts into a single component of force applied to the load transducer. Flexure mounting eliminates bearings, knife-edges, pivots and other points of concentrated wear and friction. So dependable is scale operation that W-C guarantees an accuracy of ± 0.25% of calibrated range and a reproducibility of 1 part in 2000.

The Uni-Force Platform Scale is manufactured in a wide selection of standard capacities. It is supplied as a complete, packaged unit which includes either electrical or pneumatic transmission. Because the transmitted signal can be used to actuate a number of devices, the Uni-Force Scale is readily adaptable to such automatic functions as remote indicating, recording, batching, proportioning . . . just about any weight-controlled operation.

For complete information, write for Catalog 12.

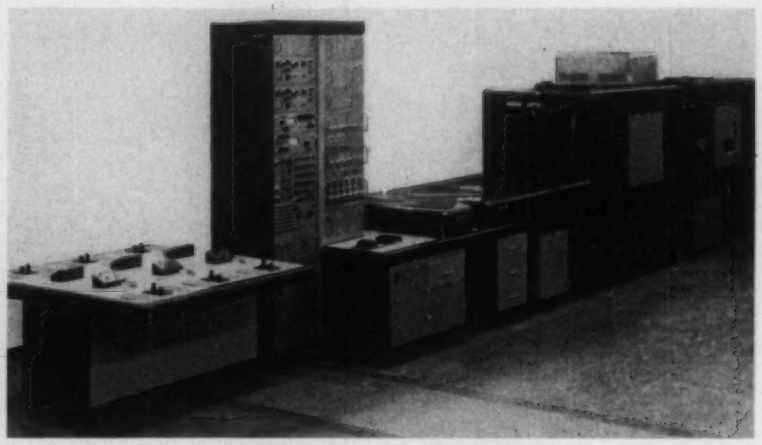
W-C

S.A. 1666

WEIGHING and Control COMPONENTS, Inc.

206-C Lincoln Ave., Hatboro, Pa.

Circle 667 on Page 133



AUTOMATIC MACHINE for processing any type of transistor through seven successive tests at rates up to 430 transistors per hour has been designed and built by Stromberg-Carlson for Sperry Gyroscope Co. The parameters in which the machine will test transistors are dc Beta (pulse test), ac Beta (small signal), saturation, and leakage. A feature of the machine is a temperature chamber in which the transistors can be subjected to any one of the tests in the series while being operated at any preselected temperature up to 200 C. Faulty transistors are automatically rejected from the machine at the station at which they fail. Operation of the machine is automatic, requiring only one operator for loading.

ferential transformers of similar size. Nominal frequency range of the new design is 60 to 10,000 cps in an ambient temperature range of −65F to 200F. . . . **Electromechanical computing device** for use in airline terminals is available from Detecto Scales Inc. Used to speed passenger check-in service, the computer records the weight of a passenger's baggage, deducts the free weight allowance, shows the amount of over-weight, and computes the charge for excess poundage according to destination. Approximately 6 seconds are required from the weigh-in to the presentation of the baggage ticket to the passenger. . . . **Solenoid valves** are now being manufactured by C. A. Norgren Co. Two series of valves are available for use with air, oil, water, and gas. Series A, available in ⅛ and ¼-inch pipe sizes, includes 2-way, 3-way, and directional solenoid valves in both normally closed and normally open types. Series B is a midget, 2-way, normally closed valve having ⅛-inch NPT ports. Both series of valves will operate up to 600 cycles per minute with a life expectancy of over 30 million cycles. . . . **Transistorized nonmechanical chopper** is available from Solid State Electronics Co. Device features small size, ¼ inch diameter by ½ inch long, and is encapsulated to withstand shock, vibration, and acceleration. Chopper may be used either as a modulator or a demodulator, and nonmechanical switching circuit provides stability and freedom from drift over a temperature range of −40C to 80C.

SPOTLIGHTING PLANTS

Power-tronic Systems Inc. is the name of a new subsidiary of Hydra-Power Corp. The new company will develop and manufacture electronic transducers, computers, and control systems and instruments. . . . **Datex Corp.** has formed an Electronic Products Development Section which will be responsible for the development of electronic digital data handling equipment, including the application of transistors and new design techniques to data handling. . . . **United States Drill Head Co.** has completed a new structure in Cincinnati, Ohio, to accommodate its Standard Pattern Div. In the near future the company will break ground at the same location for a new building to house its Machine Tool Div. . . . **Amphenol Electronics Corp.** and **The George W. Borg Corp.** are planning to merge, subject to approval of the stockholders of both companies. The merger will result in the formation of Amphenol - Borg Electronics Corp. . . . **Pioneer Engineering & Mfg. Co. Inc.** has acquired all of

How to breathe new life into your old presses . . .

Modernize! Replace the old, outdated features on your presses with brand new factory-engineered assemblies. New clutches, new slide adjustments, new bearings—these are only three of the 42 Bliss modernization assemblies you can add right in your own plant, keeping downtime and outside costs to a minimum. You can add important new press features to your old press at a fraction of the cost of a new press!

When modernizing won't do the job... consider *rebuilding*. We've rebuilt presses 20 years old and older—*restored them to their original efficiency!* We replace and refit all wearing surfaces... replace worn and outdated parts... put your press back together to its original tolerances. And we *guarantee* it.

Which is better—to rebuild or modernize? It depends upon the press and what you want it to do. Your local Bliss man will be glad to give you the facts.

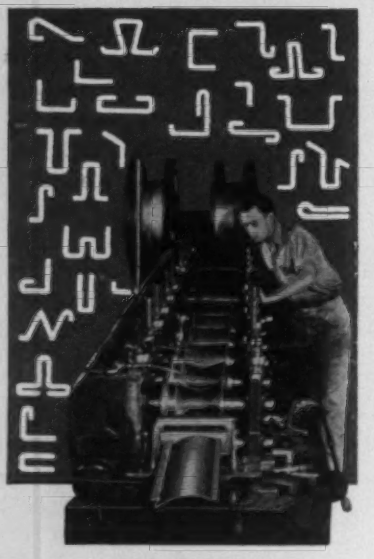
BLISS
SINCE 1857

E. W. BLISS COMPANY · Canton, Ohio

BLISS is more than a name... it's a guarantee

PRESSES · ROLLING MILLS · ROLLS · DIE SETS · CAN MACHINERY · CONTRACT MFG.

Circle 668 on Page 133



With a YODER... ONE MAN PRODUCES 30,000 FEET OF SHAPES A DAY!

Cold-roll forming with a Yoder Roll-Forming machine makes spectacular production possible in many metalworking applications and industries.

A multitude of shapes, simple or complex, produced from a wide variety of coated or uncoated stock, and destined for a virtually endless list of purposes, can be easily, quickly and economically produced with a Yoder cold-roll forming machine.

Whether it be moldings, structurals, siding, roofing, tubulars, cabinet shells, or any one of a thousand requirements, it can be quickly produced with accuracy and uniformity the Yoder way. The conversion cost is usually so low that even part-time operation makes a Yoder cold-roll forming line a profitable investment.

A great many modifications of the basic shape such as welding, coiling, ring forming, notching, perforating, embossing and cutting to length, can be simultaneously introduced with little or no additional labor cost. It will pay you big dividends to fully investigate the advantages of Yoder cold-roll forming. A fully-illustrated, 88-page book clearly discusses every important aspect of this amazingly versatile method of metal fabrication... it is yours for the asking.

THE YODER COMPANY
5526 Walworth Ave. • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING **COLD ROLL FORMING MACHINES**

Circle 669 on Page 133

the assets of Wettlaufer Engineering Co. Pioneer has majored in product design and development, manufacturing cost studies, and production engineering for a wide range of industrial and consumer products. Wettlaufer has participated in the development of designs for automobiles, refrigerators, and washing machines. . . . **United States Gauge Div.** of **American Machine and Metals Inc.** has started operations in its new plant in Sellersville, Pa. . . . **Greenbrier Instruments Inc.** has been licensed by **Union Carbide Olefins Co.** to manufacture a new process stream analyzer. The new instrument is a differential refractometer which continuously monitors liquid streams in plant processes by comparing the index of refraction of the stream to that of a liquid of known refractive index, or by measuring the difference between indices of refraction of two flowing streams.

MEETINGS AND EVENTS

Dec. 3-5—

Eastern Joint Computer Conference. Technical program and exhibit to be held at Bellevue-Stratford Hotel, Philadelphia. Additional information is available from Norman N. Alperin, Radio Corp. of America, Moorestown, N. J.

Dec. 8-10—

American Nuclear Society. Winter Meeting to be held at Hotel Sheraton-Cadillac, Detroit. Additional information is available from ANS headquarters, P. O. Box 963, Oak Ridge, Tenn.

Dec. 26-31—

American Association for the Advancement of Science. Annual Meeting to be held at Hotel Statler, Washington, D. C. Additional information is available from E. P. Lange, Secretary, Section M. (Engineering), c/o Engineers Joint Council, 29 W. 39th St., New York 18, N. Y.

Dec. 28-31—

American Marketing Association. Winter Meeting and Exhibit to be held at the Morrison Hotel, Chicago. Further information may be obtained from AMA headquarters, 27 E. Monroe St., Chicago, Ill.

Jan. 12-14—

Fifth National Symposium on Reliability and Quality Control. Jointly sponsored by the American Society For Quality Control, Institute of Radio Engineers, American Institute of Electrical Engineers, and the Electronics Industries Association, symposium will be held at the Bellevue-Stratford Hotel, Philadelphia. Additional information is available from William H. Rombach, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

Jan. 26-29—

Tenth Plant Maintenance & Engineering Show. Exhibition and maintenance conference to be held at Public Auditorium, Cleveland. Further information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 28-29—

Fifth Annual Midwest Welding Conference. Sponsored by the Armour Research Foundation of Illinois Institute of Technology and the Chicago section of the American Welding Society, conference will be held in the Chemistry Bldg., Illinois Institute of Technology, Chicago. Additional information is available from Harry Schwartzbart, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Feb. 2-6—

Materials Handling In Canadian Industry Exposition. Event to be held in the Automotive Bldg., Exhibition Park, Toronto, Ontario, Canada. Additional information is available from Materials Handling Exposition, 2 Bloor St. East, Toronto 5, Ontario, Canada.

"Just a minute, boss. We have a pool on the total shift output."

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

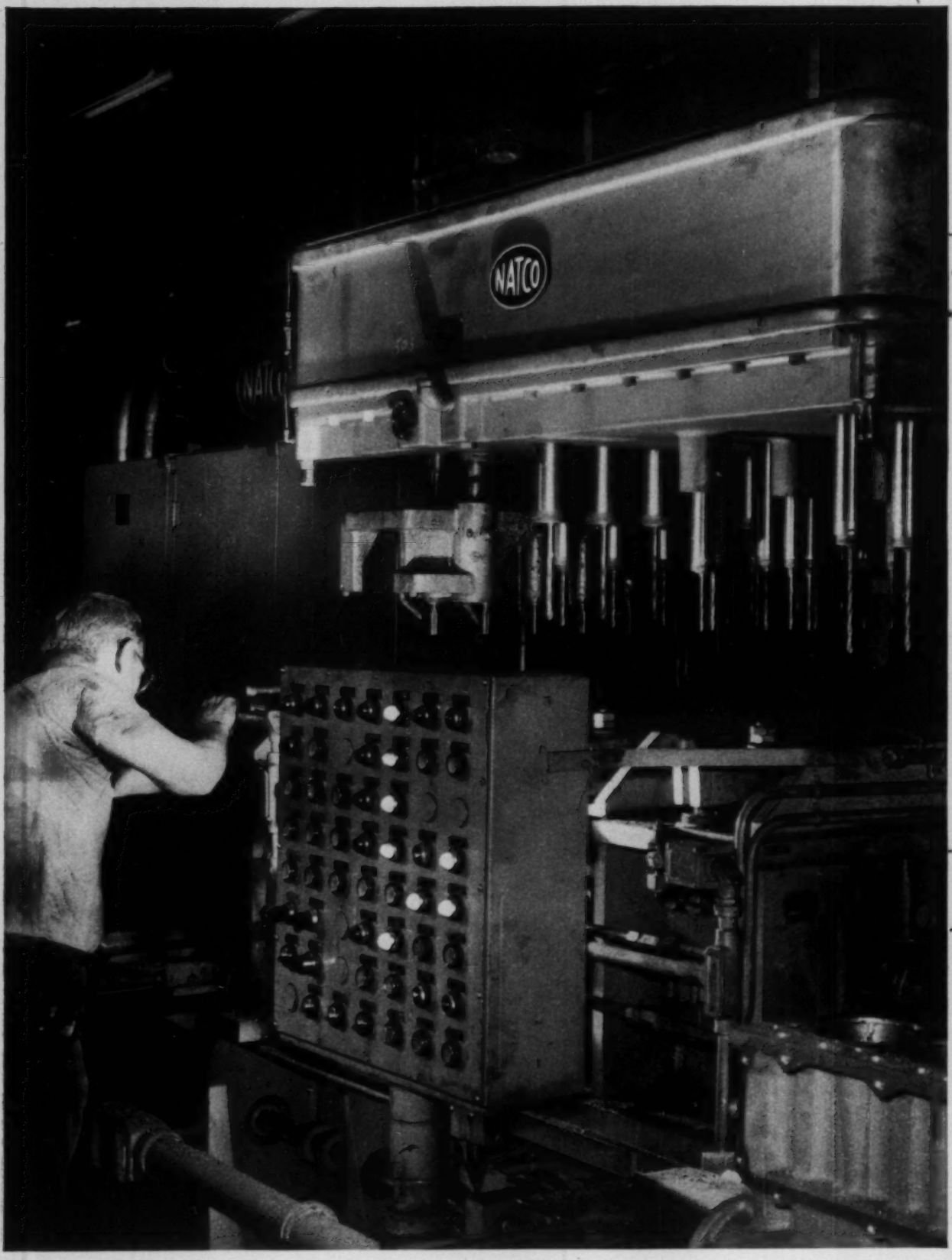
NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

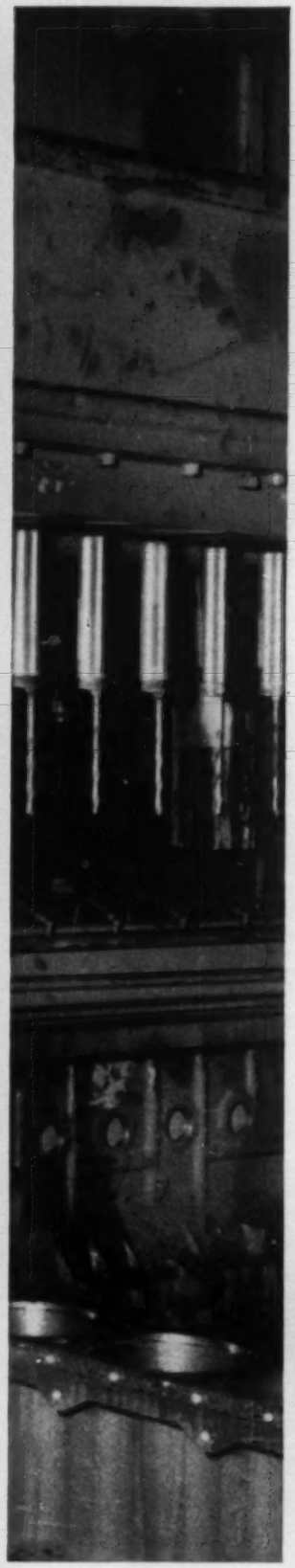
NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

Circle 670 on Page 133


NATCO



Unique Natco Transfer Machine

One head does the work of four

New Static Control saves space, maintenance

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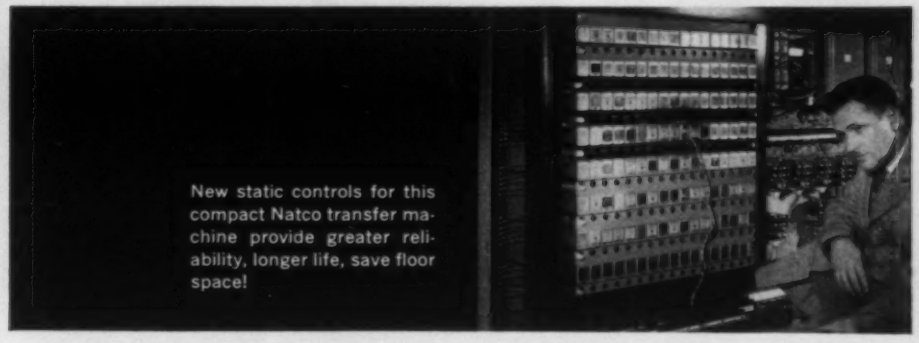

New static controls for this compact Natco transfer machine provide greater reliability, longer life, save floor space!

Circle 671 on Page 133

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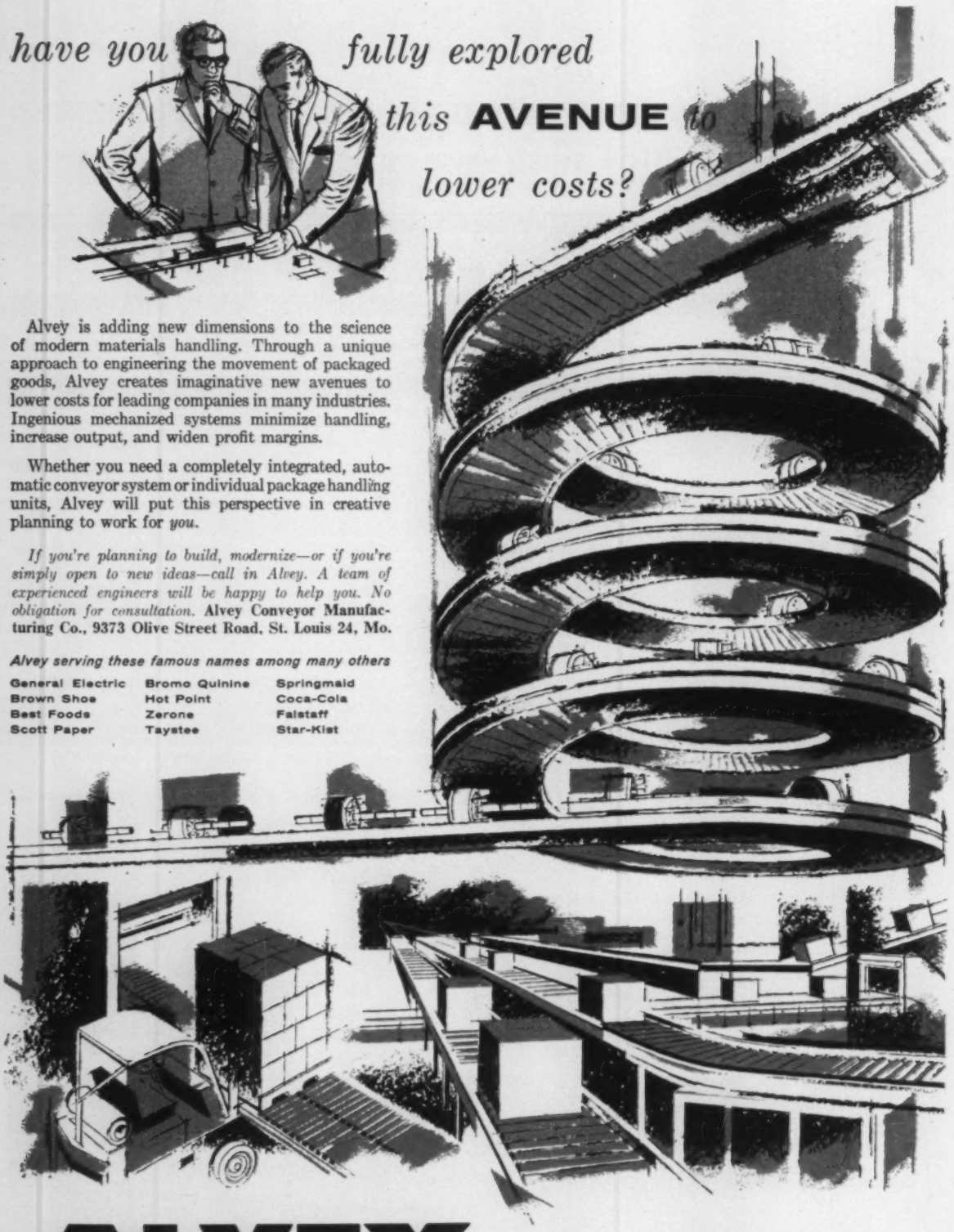

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Circle 672 on Page 133

By JAMES C. KEEBLER Managing Editor

Wired for Automation

TECHNOLOGICAL progress has obsoleted vaudeville and the streetcar, but the memory lingers on. The old gag question, "Can you tell a phone (*telephone*) from a streetcar?" may not have been really good humor but it is the kind of thing that sticks with you for years.

No Joke

Though automation has never been arraigned for killing the streetcar it might spur the revival of the old gag by substituting the words *transfer machine* for the word *streetcar*. Fact is if you are a setup man at Ford's new Lima, Ohio engine plant you can telephone from a transfer machine.

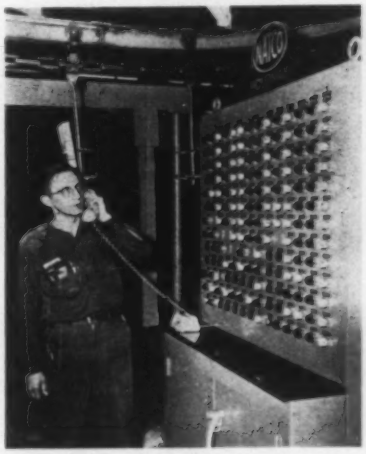
The machine is a 32-station Natco equipped with 16 conveniently located telephone jacks that enable the setup man to communicate with the operator at the "pulpit." Tool change is simplified. The setup man uses a headset arrangement that allows him free use of his hands. By verbal communication with the operator he can have him push the required button at the required time and save much of the time and steps that might otherwise be required to test his adjustments.

Besides being wired for sound this machine is also wired to distinguish between engine front covers for autos that are to have power steering and for autos that are to have conventional steering. These parts are alike in most respects. Limit switches sense the power-steering unit boss and cause the affected stations to go through the proper cycle.

Such machines provide not only the machining functions necessary to make the parts, but the handling functions necessary to move them from station to station, plus the controls necessary to make both of the aforementioned operate automatically and incorporate a few bonus features such as inherent flexibility and ease of setup. This is what the automaters are thinking about relative to all operations.

Complexity Compounded

Accomplishment of these goals involves some rather complex circuits. The transfer machine is often considered as the most complex of machine tools, because it involves not only the automatic functioning of a workstation but also the interlocks required by its multistation nature.



Telephone communication from main control panel to any of 16 jacks on Natco transfer machine at Ford's Lima, Ohio engine plant expedites tool changes.

Electrical ramifications were discussed at the 1958 American Institute of Electrical Engineers Machine Tool Conference in Hartford. Particularly noteworthy was a comment overheard between technical sessions to the effect that not so many years ago it seemed that the only electrical gear that the machine tool builders worried about was a motor and its starter. Now in the age of automation the needs differ. The boys (688 paying participants) had come to discuss: numerical control, transistors, vacuum tubes, static controls, relays, limit switches, servos, dc drives, rectifiers and gaging.

This comment was passed along to participant Alex Stewart of Fawick's electric clutch group who responded that he had observed the electrical engineers moving into more top positions in machine tool building companies. He wondered if the managements weren't finding it easier to teach the mechanical side of their business to these amp and volt boys than to try to teach electron theory to the nut and bolt grads.

Boss Sez

This kind of conversation soon gets us to the point of talking about bridging the gap between those that know and those that have need to know.

Boss Ket has lately taken to admonishing engineers as a whole to come off the ivory tower of specialization. Soon no two well-educated men will be able to hold an intelligent conversation with each other because each will be unfamiliar with the jargon of the others' specialty.

On the other hand this age of experts may well be already beyond the point of no return. A more practical approach to the problem might be to teach co-operation to the specialists, rather than try to make each thinker a jack of all thoughts.

Certainly if there hadn't been some high-powered specialists cogitating on how to wire up the latest ideas in production machinery, the automakers wouldn't have to be deciding on such issues as: dc vs ac drive motors, static controls vs magnetic relays, mechanical vs proximity limit switches, hydraulic vs electrical servos, or transistors vs vacuum tubes. Without the fruits of specialization these decisions

wouldn't be faced because half that stuff wouldn't have been developed.

Specialized Problems

Those who develop new circuit techniques and components are still faced with the problem of communicating with those who buy and use the machinery. The customer is *still* king. Unless he can understand something about what he's buying he's not likely to risk it. Unless it works when he tries it he's not likely to buy another.

So the wiring expert who peddles new ideas must not only explain his wares but must follow enough of them through in service to know that the gadgets really work where the working counts.

Technical conferences and technical journals are a boon to both parties of this transaction because they offer a sounding board for the builders to explain his merchandise and for the user to document his experiences.

Automakers are to be commended for the good job they do of spelling out their problems. In a paper entitled "Operating Experience with Magnetic Control" Pontiac's L. S. Thomas, chief electrician, explained how their IBM system of recording maintenance activity has enabled them to pinpoint electric problems.

The Pontiac system of keeping track of trouble has been in operation over three years. During this time they have reduced machine downtime hours 13 per cent and number of downtime maintenance calls per unit 14 per cent. The record system alone cannot claim full credit for this improvement, but it is one of the principal factors.

For one thing it has helped them differentiate between cases of downtime due to normal component failure and those due to misapplication of components. Further, by keeping score of the "parts affected" they are able to show that 60 per cent of their electrical troubles come from four causes: 1. Limit switches 28.5 per cent. 2. Solenoids 19.5 per cent. 3. Relays 8.0 per cent. 4. Defective wiring 4.0 per cent.

Considering that relays outnumber limit switches by two to one and solenoids by two and a half to one the reliability of the relay looks pretty good.

Because limit switches are the big offenders they are getting special attention. In the laboratory these switches give 3,500,000 operations before failure. In actual practice on Pontiac's machine tools the average is 650,000 operations before the first failure or between failures.

These figures point to a need for better selection and application of limit switches by machine tool builders. In laboratory tests external conditions are ideal. In service, dirt, oil, coolant, and misapplication are present.

Safety First

Just as the gaging specialist justly complains that the machine tool designer did the whole job without leaving him a place to bolt on his in-process gage, so the safety engineer cautions that the safety aspect of the electrical system must be considered early in its design.

If safety comes first (not last) the machine need not be a mantrap to those who set up and maintain it. Thomas recommends that enclosures be designed with the switch handle on the door, but always in control of the switch, even with the door open. This would discourage the practice of putting the system back on the line without tightly closing the door.

The people at Pontiac are so concerned about the safety aspects of such electrical equipment that they have actually built an enclosure to their ideas of what it should be like.

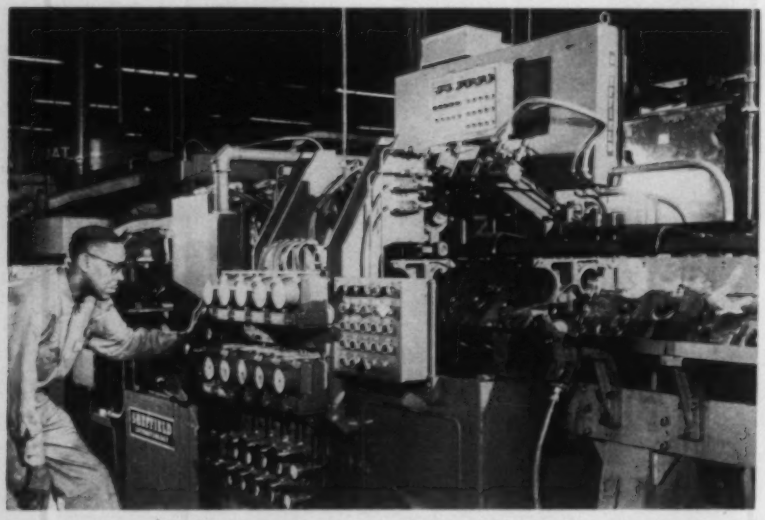
This unit requires a tool to get the door open, the switch must be *Off* or the door won't open, and the switch handle is still engaged with the switch mechanism when the door is open.

Big Job

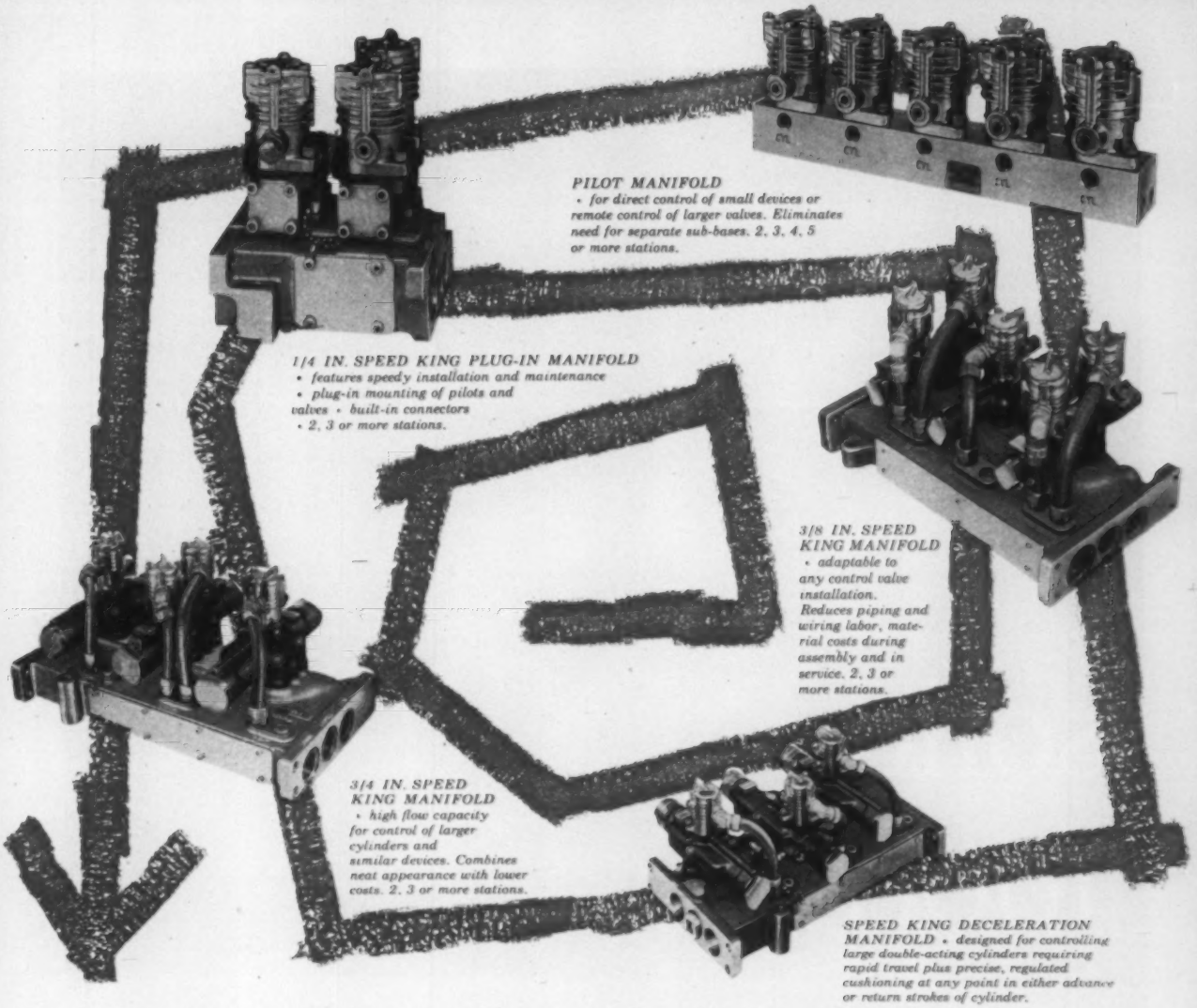
When machinery gets big enough to require telephones for intermachine communication, it's too big to risk accidental startup of all or part of the mechanism at a time when someone has his hand in the works. To avoid such accidents every known protective measure must be considered in the design of the interlocking control systems.

Special one-of-a-kind automated machines are really toughest to wire for they represent new combinations of hazards that challenge the best planning brains of the system engineer.

For production machines to be properly wired for automation it is important to include the best ideas of the specialists that design electrical components and the jacks of all trades that plan the production processes and maintain the equipment.



One of the highlights at Ford's new engine plant in Lima, Ohio, is the extensive use of gages to check parts during machining processes. This automatic gage checks various diameters in the engine block and rejects blocks that fail to meet engineering specifications. Use of the in-process gages has led to greater quality in the Edsel, Mercury, Lincoln, and Continental engines produced in the plant.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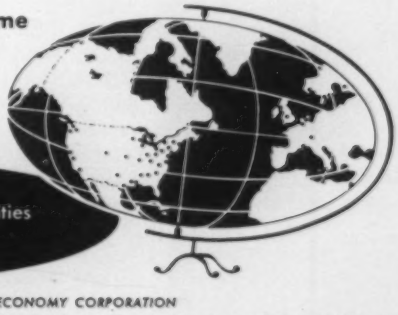

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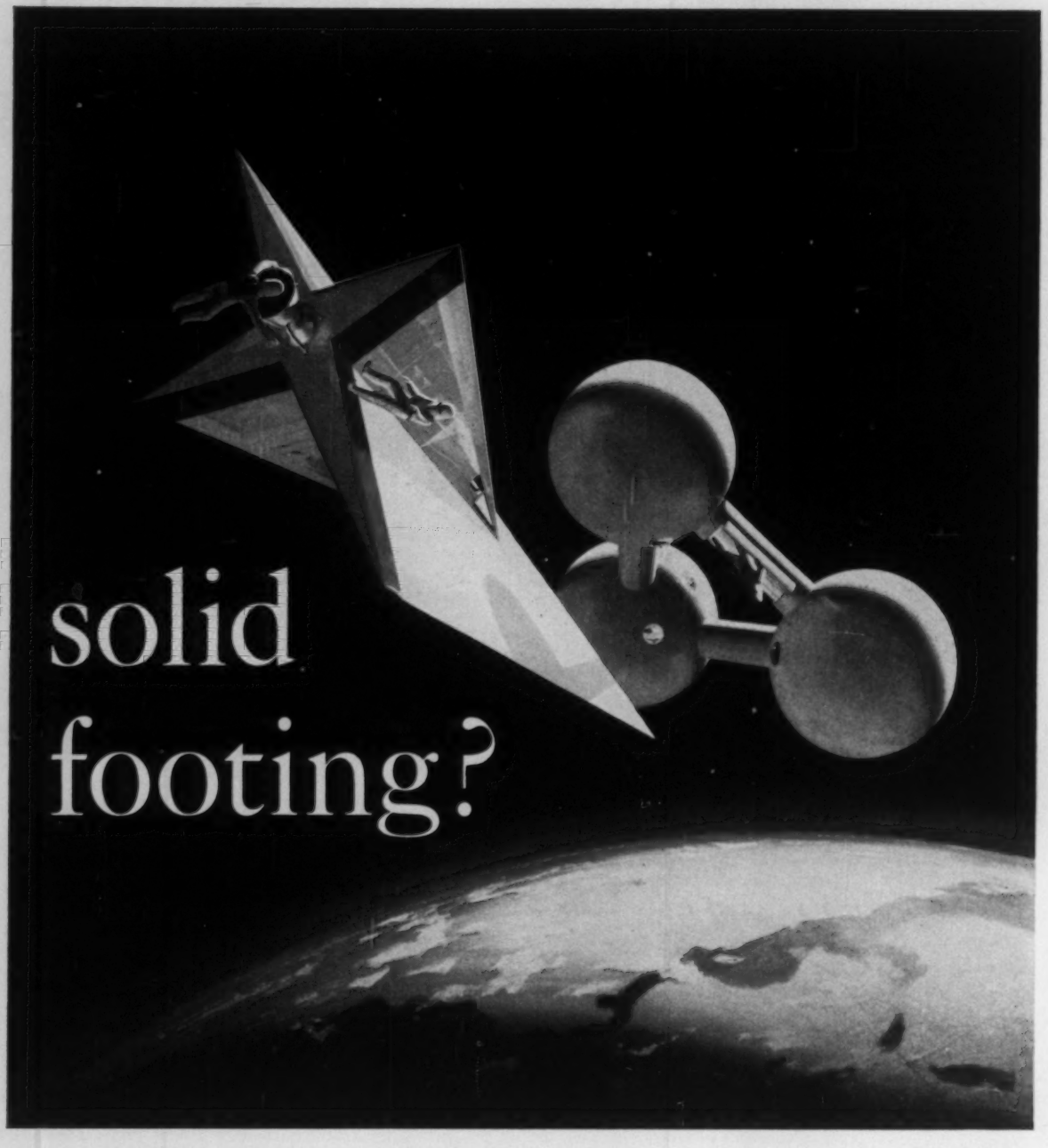

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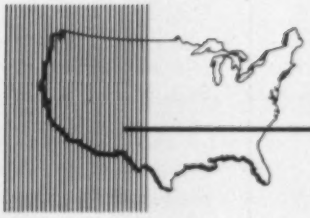

western roundup

By PATT PATTERSON
Los Angeles, Calif.

Autonetic's Numill, three-axis numerical control system controls a Brown & Sharpe milling machine for the precise drilling and milling of a complex helical part. Scribe-Template Programs used by Numill to produce airfoil sections consist of an integration of proprietary North American Aviation design-intent programs with the Automatic Programming of Tooling, a joint development with the Aircraft Industries Association.

Missile Making Operations

BECAUSE today's missiles are still in the development stages, production of any single type has not reached major proportions. Nevertheless, the major prime contractors, anticipating the day when production will be measured in hundreds and thousands instead of today's dozens, have applied automatic techniques to single machines and processes.

Because the average Western airframe and missile manufacturer has a great need for highly specialized machines, yet has small, highly variable production runs, he has often modified or built equipment to his own specifications. With the growing knowledge of benefits realized from use of automatic controls, a number of Western aircraft firms have pioneered in producing automatic control devices. Some of these are turned over to established machinery manufacturers to market, and others are sold under the aircraft maker's own name.

The latter case has been true of North American Aviation, Inc. The company's Autonetics division in Downey, Calif. introduced a numerical machine control system about a year and a half ago. The system, called Numill, was designed to automatically operate any two-axis machine for the production of any part within that machine's capabilities.

This fall, Autonetics unveiled a new version of Numill. The new device is a three-axis control system, capable of directing almost any type of production machine tool which is servomotor driven. The new system is actually in operation at North American plants, turning out tooling and parts with tolerances of 0.0002 inch.

The new system directs the machine by converting information from computer-punched tapes. An electro-optical gaging system feeds back information on position of each of the machine's three axes to the control console, where the actual position is compared with the taped instructions. Tolerances achieved by the system are in the order of 0.0002 inch. Any digital computer can produce the 7 or 8-channel paper tape required by Numill. If a computer output is not directly in tape, a tape punch may be added, and will produce suitable instructions for the control system.

Food Techniques

From aircraft and missile parts production to food handling and packaging seems a long, and completely unrelated step. Perhaps it is. There are certain similarities in the problems faced by the food and drink producers of some years ago, and the situation in which parts manufacturers find themselves today, however.

The processing industry is now one of the most automated of the many food handling fields. The reason is simple: The manufacturers found manual methods inadequate and uneconomical. Some years ago, food processors discovered that one of their greatest problems was sterility.

The greatest source of contamination, and the hardest to do anything about, was the human worker. So the obvious solution was to automate and perform the work with machines that would be able to stand the heat, and chemical or ultra-violet sterilization necessary.

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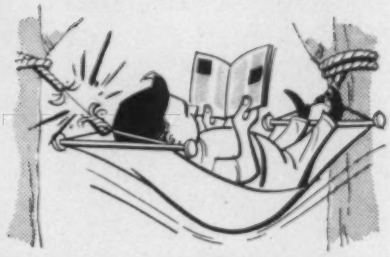

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In the missile field today, with tolerances becoming ever more precise and critical, the manufacturers find themselves in somewhat the same position. Sterility is not a problem, but foreign matter contamination and oxidation are. One answer is the "clean" room, where critical and miniature parts are assembled in as dust-free an atmosphere as can be obtained with air conditioning, pressurization, humidity control and dustless garments.

Still contamination is a problem. Therefore, a number of leading missile component manufacturers have been looking with curiosity at some of the techniques employed in the packing of food products. Such methods as packing in an inert gaseous atmosphere, complete lack of human contact with the process, mechanical assembly of parts, all are under scrutiny by metalworking firms.

In the not-too-distant future, we may see parts such as the ultra-precise hydraulic servo valves used in missiles assembled completely mechanically and automatically, in a humidity free chamber, under an inert gaseous atmosphere. Redesigning of parts would be necessary to adapt many of them to mechanical assembly, but the means, and the control systems are in existence, and require only the development to make them work.

Western Notes

Thornton Canning Co., Thornton, Calif., has a special automated drum filler that was developed by Rheem Mfg. Co., and Thermovac, Inc. The unit fills the drums in a sterile pack chamber under an inert gaseous atmosphere. Food, pasturized, but uncooked, has been maintained at room temperature for as long as a year in the drums.

Pollock Paper Corp. has a new plant which has been automated for the production of waxed paper.

An automated filling line for detergents has been installed at the White King Soap Co. plant in Los Angeles.

Food Machinery and Chemical Corp. has a new idea in egg "candling" equipment in the development stages. This is a job that experts predicted would "always" remain a human operation because of the necessity for a broad range of critical decisions.

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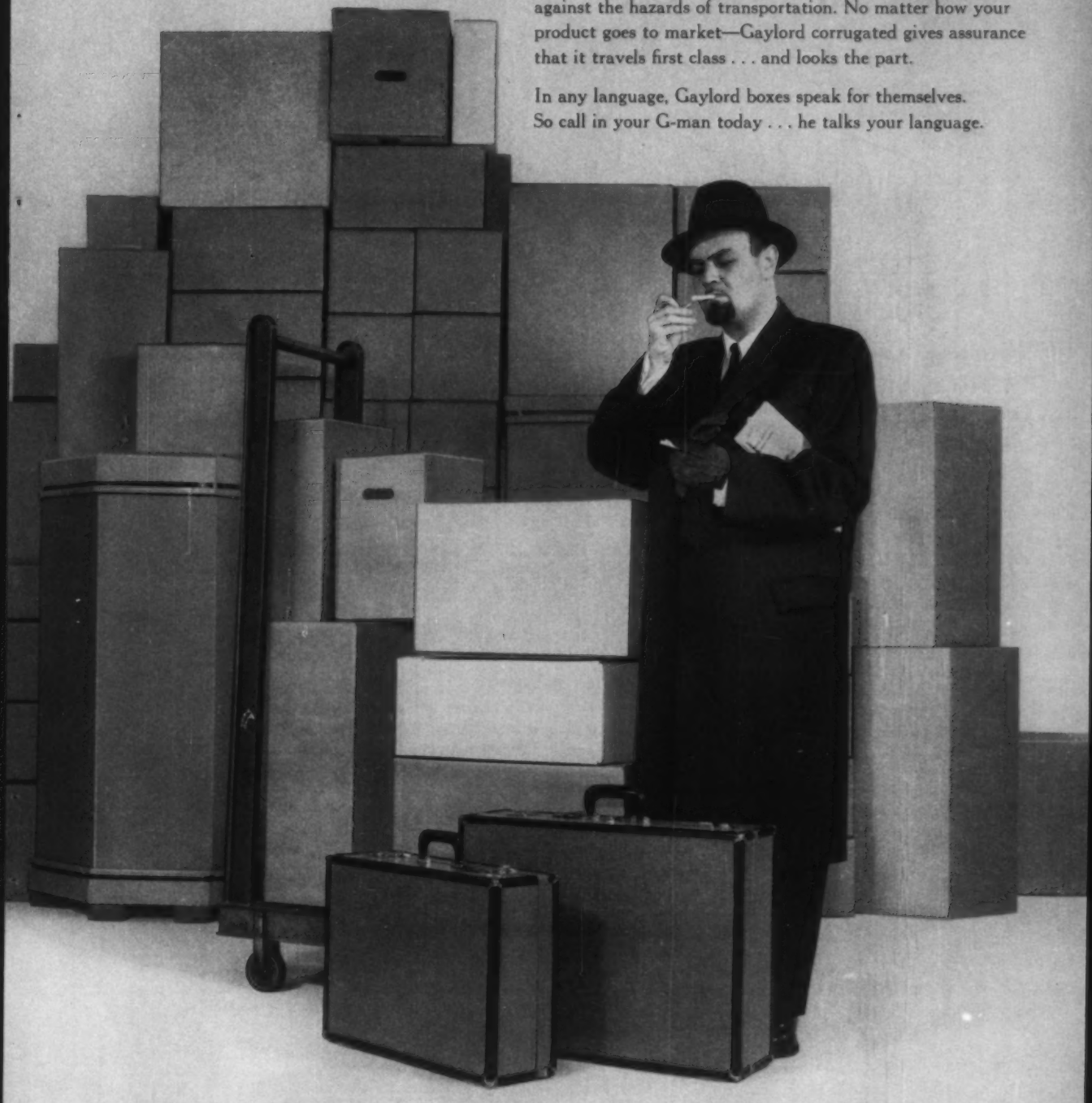

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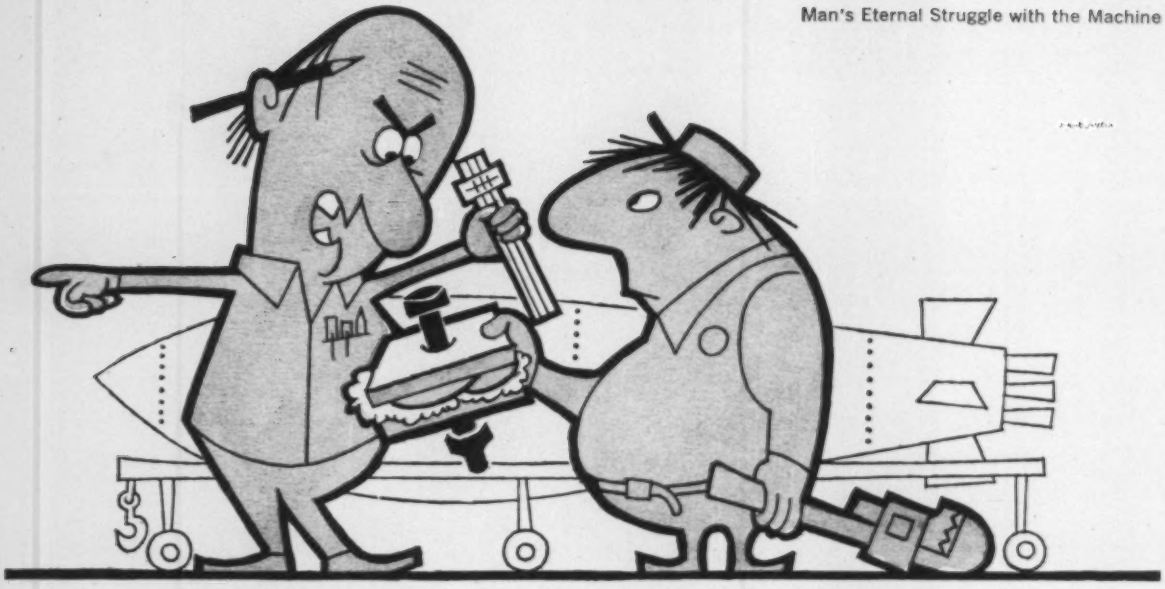

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Circle 677 on Page 133

A Practical Answer

Capital equipment for production processes poses a major policy problem for most industries. Despite the time-honored practice of considering production machinery as capital goods, such equipment for the most part must be looked on as expendable tooling, good only for the active life of a product or process. To do otherwise can, and often does, place the business in a strait jacket with regard to costs. Yet businessmen find it hard to change their age-old practices, even though these obviously are unfit.

Invariably, new machinery is discussed in terms of payoff in the first few months of operation. And with careful study, payoff is assured—consequently machinery cost is recouped in full whether considered from a current expense or a capital standpoint. Nevertheless, there is considerable talk of depreciation limitations on machine replacement, although Congressional studies indicate few businesses have taken advantage of depreciation methods now available.

Where does the real problem lie? It appears that depreciation talk to a great degree merely screens the real restraint—shortage of available working capital to tie up in equipment. And, practically speaking, there is also a fear of possible equipment obsolescence before sufficient time has elapsed to permit suitable return on capital invested in that equipment.

Today, equipment leasing offers management a practical answer for the problem that has created this restraint. Leasing offers a twofold approach to putting productive equipment on a modern current-expense basis—pay as you go, and replace and upgrade as competitive conditions demand. Working capital is conserved. Short-term leasing from three to five years is available, and equipment disposal can be handled by the leasing corporation, making replacement simple.

A potent factor in the future development of industrial automation, leasing can help tremendously in preserving business and profits by making more manufacturing expenses current and simultaneously modernizing equipment policy into a more realistic one considering machines as expendable tooling.

EDITOR

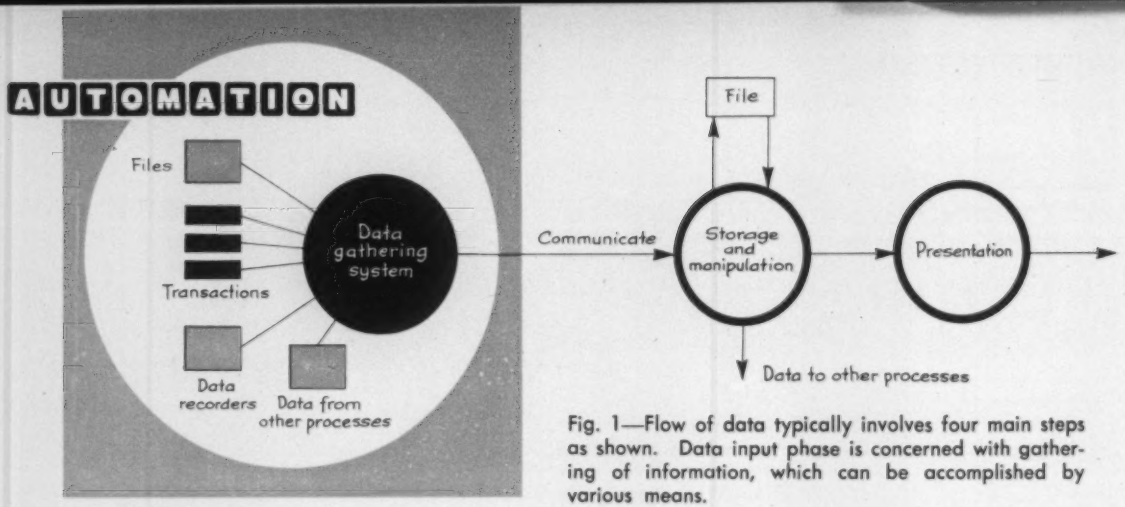


Fig. 1—Flow of data typically involves four main steps as shown. Data input phase is concerned with gathering of information, which can be accomplished by various means.

ERROR CONTROL IN DATA INPUT SYSTEM DESIGN

Part 1

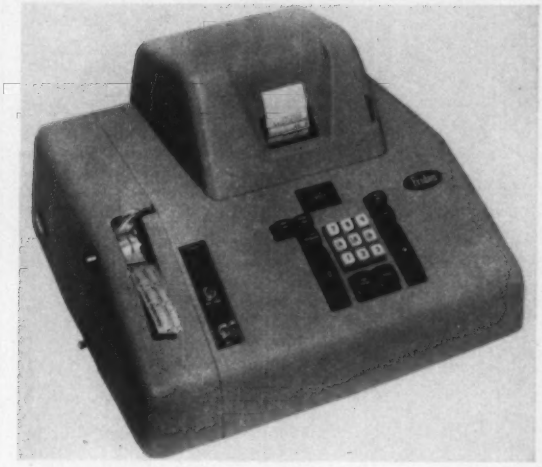
Redesign of an existing data input system has a good chance of resulting in a payoff—provided all factors are considered during the redesign. This first part of a two-article series on data input is concerned with error control and its importance to data handling systems.

By **ROGER L. SISSON**, Canning, Sisson and Associates, Los Angeles, Calif.

DATA PROCESSING systems, like manufacturing systems, involve a series of steps. Each step is complex and must be executed properly, if the end results—management reports—are to be worth anything. Just as it is necessary to build a product out of the correct raw material, it is necessary to build management reports from the correct input data.

Data processing involves four major steps: Recording the data, communicating the data to a processing center, storing and manipulating the data, and presenting the data. *Fig.* 1 illustrates this flow.

The advent of tabulating equipment and electronic computers, and the attendant development of data processing systems, has permitted the mechanization of data manipulation and storage and, therefore, made these operations more economical. To date there has not been a similar degree of improvement in data recording, nor in data communications. Nevertheless, new data recording equipment, *Fig.* 2, is becoming available and, when used, significant improvements in many data input systems can be made. In fact, many small businesses now can obtain direct savings and improved reporting through a better input system, even though they cannot justify electronic data processing (EDP).



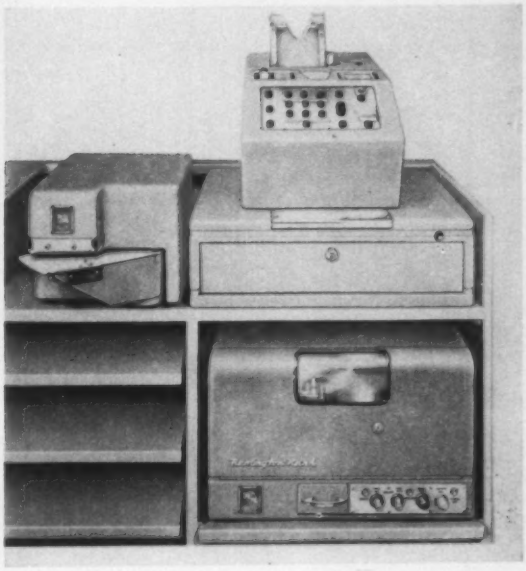


Fig. 2—Examples of modern input equipment which offer users improved reporting. The Friden Inc. Add-Punch (left) lists items and totals on machine tape and at same time automatically punches selected data on paper tape. The point-of-sales recorder by Remington Rand Inc. (right) includes a tag reader, cash register, and paper tape punch.

Data Recording

At the present time, data are originally recorded almost entirely by having a human write it down. Often the data are recorded by operating personnel, such as machinists, sales clerks, and salesmen—none of whom are trained in clerical procedures. The result is that the data as initially recorded contain a high number of errors (from 1 to 5 per cent). This necessitates expensive and time-consuming editing and correcting steps between the recording of the data and the basic manipulation and storage. Often the editing is not a specific clerical job, but is performed informally by logging clerks, transcribing clerks, and others. One operator will catch the errors created by another; for example, one dispatcher may correct an error made in a previous processing department. Thus, some editing costs are hidden.

The number of errors and the cost of correcting them, hidden or not, is becoming greater as businesses require more information—a result of diversification, and decentralization. A good EDP study uncovers the high error rate and the large amount of manual editing required. In fact, where the EDP study does not cover the input area, management is often surprised by the numbers of errors "kicked out" by the computer when it goes into operation.

Determining Requirements

Because of the complexity of data systems, in redesigning a system it is necessary to study the existing one in order to define all of the details of a new system. Of course, certain of the existing features may be discarded or changed, but a review of them prevents the overlooking of vital points.

The study of the existing input system may be a part of a broad study of the company's data processes. In almost every firm an over-all study will pay off and is highly recommended. If a program for a broad study does not appear to be feasible in the beginning, a study of major input areas is often profitable in itself and easier to get started. As a general rule, wherever there are employees, such as timekeepers, who devote a substantial part of their time to data recording, there is a good chance that a mechanized data input system will pay off. If the data recording is performed by operating people, a mechanized input system may be hard to justify economically, unless it is part of a larger data mechanization program.

Assume that an area of data input has been chosen which promises possibilities for improvement and in which data vital to the company's business are recorded. What is the procedure for analyzing the problem and designing a system which will control errors and reduce the time between recording and processing in an economic way? The answer to this question will be developed around the familiar example of data processing in a department store; it should be kept in mind that the method is usable in all data input problems: In manufacturing plants, stockrooms, wholesale operations, etc.

Typical Approach

In a department store the recording of data on the sales floor is the major input area. Here are the steps which have been found necessary in analyzing an existing system and determining the basic requirements:

Step 1. List all of the types of transactions that

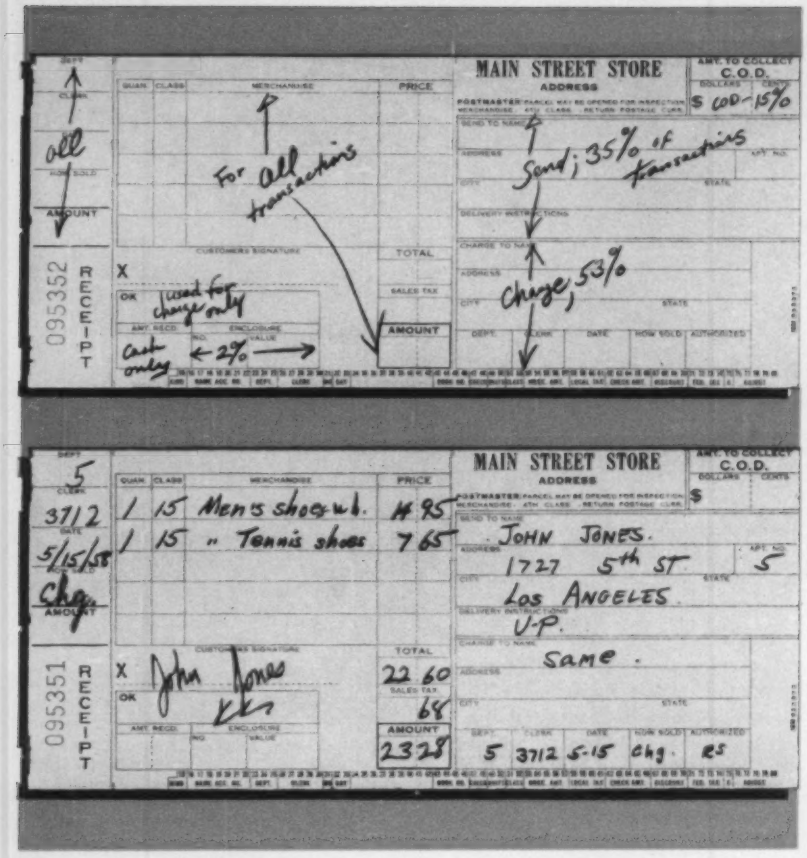


Fig. 3—In making survey of input systems it is helpful to obtain two copies of forms already in use. One copy should be filled out with typical complex transaction; the other copy can be used to record statistical data about fields of entry.

are recorded: Cash sales, charge sales, COD's, returns, payments of bills at the cash register, etc. Low volume, but important, transactions such as exchanges of merchandise should not be neglected.

Step 2. Determine, by area (department and cash register), the volume of transactions—both average and peak. Since a mechanized system cannot be expanded temporarily to cover peak loads, as can a manual system, it is most important to obtain peak volume data. The peak may not be at the same time in each area, of course.

Step 3. Next obtain a list of the fields, or items of information, required for each type of transaction. For each field determine: The number of characters required (average and peak) and what per cent of the time the field is required. For example, on a cash sale you may find an average of 2.5 item descriptions and 2.5 price fields on each. Maximum figures should be obtained also. It is important to note whether each field is preassigned or variable. For example, the salescheck number is preprinted, and the item number is preassigned and on the merchandise tag. But the quantity the customer buys is variable; it cannot be predicted. List the source of data for each field.

In studying the inputs, do not neglect the inputs which serve auditing functions. An operator is also an employee who must be paid, and often a copy of the input record, such as a job report or the employee's signature on it, serves as proof that the operator worked on the job and is entitled to incentive pay. If a mechanized system is proposed, it must either provide the equivalent audit data, or you will have to sell the employees and auditors that the audit data are not really needed. Similar situations exist for sales clerks who are paid a commission and for stockroom personnel responsible for losses. The extent to which signatures on forms and copies to employees are really used can, therefore, be an important factor.

One of the most direct and least time-consuming methods of gathering the information about the present inputs is to collect all of the forms presently used. Do not neglect to cover important telephonic inputs, however. For each form, obtain a blank copy and a copy filled out with a complex case. The blank copy can be used to note various statistics about that form of input. *Fig.* 3 shows how data might be collected about a type of transaction.

If the input study is part of a larger program, it may be possible to eliminate some fields from detailed survey immediately, since in a mechanized system these fields need not be recorded but can be picked up from master files during the processing.

Steps 1, 2, and 3 should be repeated for the outputs of the data input system (the inputs to the data processing center) where the output forms are different from the input forms.

The above three steps are obviously important to understanding the data input requirements; the next four are equally vital, but are often passed over too lightly. They do not take long and are well worth the effort in time saved during the design phase.

Step 4. List all of the types of errors made in the input, and for each, the number of that type of error per transaction. For example, the clerks put down the wrong unit price once in 100 transactions; they incorrectly multiply to get the total price once in every 50 times that such multiplication is required, which can be, for example, once in 500 items sold. A good analysis of errors will permit a more intelligent design of the mechanized error detecting and correcting method.

Step 5. It is useful to observe the environment in which the data are recorded. Is there dust, noise, vibration, or poor lighting? Are the basic data generated by manual processes such as counting, reading, and oral communication, or are they generated mechanically? A mechanical process lends itself to a mechanized form of data recording which can be easily designed since the requirements of the recording process are easily determined, and the data recording mechanism cost is a small part of the total equipment cost.

Step 6. Since we are interested in cases in which data are initially recorded by humans, the psychological factors should not be overlooked. These include: The organizational position of the people who must record the data; the attitude of the operators toward the clerical aspects of their job; and the amount of training in clerical procedures to which the workers have been exposed. Generally, operating people do not like the clerical aspects of a job, even if they have been trained for them, and operating supervisors are prone to be careless with data which they record for use by other departments. This can be overcome with proper personnel training, management orientation, and with good error detection and correction systems.

Step 7. In most cases the data must be transmitted from the point where they are recorded to where they will be stored and processed. Often a mail system is the obvious method, but a survey of all possible communications methods is desirable, especially if interplant and intercity communication is involved. For each possible communication system obtain: Cost per character or message, characters per second, and error rate under normal operating conditions (not with the system "tuned up" to peak performance).

The data outlined in the seven steps must be gathered before a satisfactory input system can be designed. Often the survey will take only a few man-weeks on the part of a systems man. If, however, these factors are not known, the final system may bog down due to errors, unco-operative personnel, or a failure to handle all of the possible inputs satisfactorily.

▶ Design Considerations

Unfortunately, there is no exact method of designing input systems, as there is not yet any good basic theory of business data processing systems. As we have seen, psychological, equipment, and procedural factors are all involved. An experienced systems man, however, can usually arrive at the most economic data input system which meets all technical requirements.

Although the equipment to be used will influence the methods of error checking, a description of the design of the error control system will be a good

TABLE 1—TYPICAL REDUNDANCY CHECKING METHODS

Type	Typical Use	Redundancy
Parity	Checking magnetic tape data transfers	One binary digit of 7
Redundant	Checking internal computer transfer and arithmetic operations, e.g., in Datamatic 1000	4 binary digits of 40
	Self-checking number systems	One decimal digit of 7
	Calculating and checking "batch" or control totals	Typically 10 digits of 1000
Duplication	Repeating complete message transmission (duplication in time)	100%
	Duplicate arithmetic logic, unit, e.g., in Univac	100%
Reasonableness	Checking to see if data deviate by a given percentage from an extrapolation of previous data	The computation involved in extrapolation, comparison and storage of limits*
Consistency	Checking agreement of stock number and name	Storage of correct combination and checking calculation time*
Completeness	Checking to see if a field is missing or if an item is skipped in a sequence	Checking calculation time*

Such checking typically consumes 10% of the time for a complete calculation.

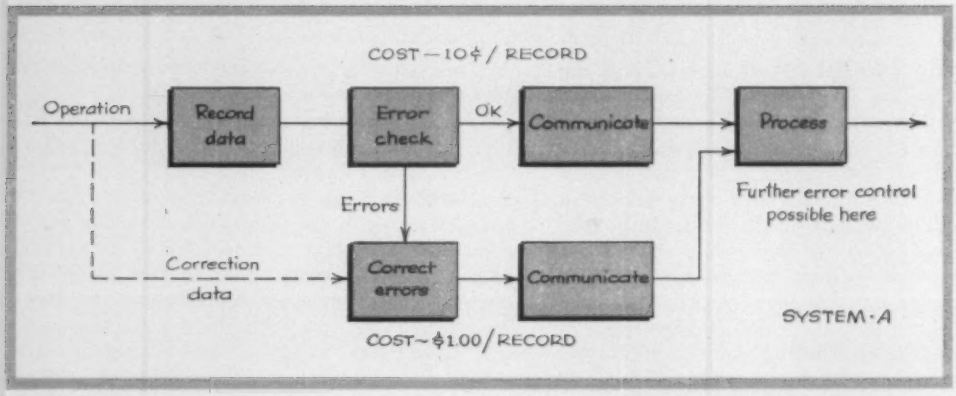


Fig. 4—Block diagrams compare two possible systems which are distinguished by the point at which error detection function is located. Price figures indicate cost per record to accomplish checking and correcting operations.

starting point since error checking adds to the data which must be handled and to the procedures required. Error systems depend upon redundancy, that is, upon sending more information than would be required in an error free system. The important rule is that the extra or redundant information should be added in a controlled way, so that just enough is added to reduce the error rate to the acceptable level. If the redundancy is inserted haphazardly at the whim of the operating people, they may become over-redundant, for example by duplicating everything, which is costly. As shown in TABLE 1, taken from the forthcoming *Handbook of Automation, Computation and Control, Vol.* 2, John Wiley & Sons Inc., there are various types of error checking.

Each preassigned field can carry a precalculated checking digit. This is the technique used inside computers (the parity check) that can be effective in input systems also. Consider an employee number, 61248. One method of checking (used in the IBM type 26 keypunch) computes and assigns an extra digit to the number and uses it throughout the system. The extra digit is computed by taking the evenly placed digits (1 and 4 in the employee's number) and two times the odd digits ($2 \times 628 = 1256$) and creating a number (141256). The sum of the digits ($1 + 4 + 1 + 2 + 5 + 6 = 19$) is then subtracted from the next highest number ending in zero ($20 - 19 = 1$). The check digit is 1 and the number used throughout the system then is 612481. Whenever a record enters the system containing this field, it may be checked by automatically recomputing the check digit and comparing it to the one appended. This particular type of check can detect most transpositions and substitutions of wrong digits—the common clerical errors.

Groups of fields (related or not) can be checked by batch, control, or hash totals. Batch and control totals usually have some significance, such as the total dollar sales of a cash register for the day. A hash total does not have significance. The total of the sales check numbers would be a hash total. In either case, the totals are the redundant information. The batch or control totals are checked in the processing center and at other points, such as after communication, to detect errors in the input.

A broader look at the data flow will often permit the comparison of data from two inputs or the input and a file (earlier inputs) to develop consistency and reasonableness checks. For example, a sale for over $100 from a cosmetic counter would appear to be unreasonable, and further checking would be desirable to prove it to be legitimate. An employee number may be checked against a department number to determine whether they are consistent: Could that employee have actually been working in that department at the time?

In present data input systems, clerks very often make reasonableness and consistency checks of this type. A clerk will often note unusually large orders, extra overtime, wrong department numbers, etc. Sometimes they will make corrections themselves by guessing, which is not conducive to correct data. In any case, it should be clear that a computer can

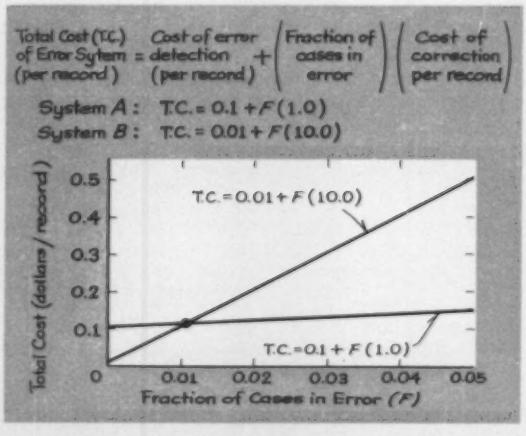
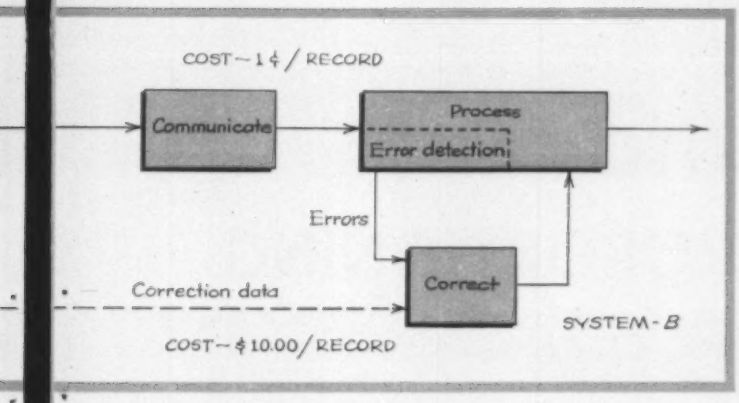


Fig. 5—Comparison of costs for two systems shown in *Fig.* 4. System A is cheaper where higher error rates are encountered.



be programmed to make almost any check that a human does. But because computers do not have the memory size nor computing facility of a human, the cost of making these checks in the computer can be expensive.

The first problem in design is to determine where error checks should be made. From one point of view the check should be made as early as possible in the series of steps starting with recording of data and continuing to input and processing. This permits the correction loop, as illustrated schematically in *Fig.* 4, system *A*, to be as simple and inexpensive as possible. After recording, the longer the error remains undetected and the greater the number of organizational groups the data has passed through before the error is detected, the harder it is to locate the difficulty.

On the other hand, if the error rate is low, it may be better to wait until the data get to a computer to detect errors since the cost of handling the nonerror cases will then be lower. Consider the two arrangements in *Fig.* 4. System *A*, which might represent clerical review of incoming documents, is expensive but the correcting process is low in cost. In System *B* the unit cost of detection is inexpensive, being fully mechanized. However, since it is accomplished later in the system, considerable effort can be required to correct the errors found. In *Fig.* 5 the costs of the two approaches are compared. Note that system *A* is less expensive for high error rates (above 1 per cent) and that system *B* is less expensive for error rates below the 1 per cent level. The value of measuring the error rates in the initial studies can now be seen, for, although they might be changed by the new system, at least the order of magnitude is known. The same type of analysis should be applied to errors in communication which might occur.

The second design problem is "how much checking?" In other words, how much redundance must be added and how often will checks be made? As a general rule the cost of error detection and correction should not be greater than the cost of letting the error get through to affect the files and output reports. The cost of error detection and correction can and should be estimated for any proposed system. The cost of letting an error go through is harder to measure. Sometimes information from an over-all study of the data system will permit estimating the cost of errors. If not, it should be determined by management. The following procedure will simplify obtaining an exact decision about the cost of errors (for example, the errors in statements to customers).

Design several possible systems, both manual and mechanized. Study each to determine how the operating cost of the system (with initial costs properly amortized) will vary with varying amounts of error detection and correction. It should then be possible to plot a curve as in *Fig.* 6 which shows how the cost of error control will vary with the error rate. Generally, an over-all curve may be roughed in through the curves for specific systems, and will have the general shape shown in the illustration. Note that the point identifying error rate and cost of correction for the present system should be plotted as a comparison. In seasonal businesses the costs should be computed over a year to cover both average and peak conditions.

This curve may then be presented to management, so that they can pick an acceptable operating point.

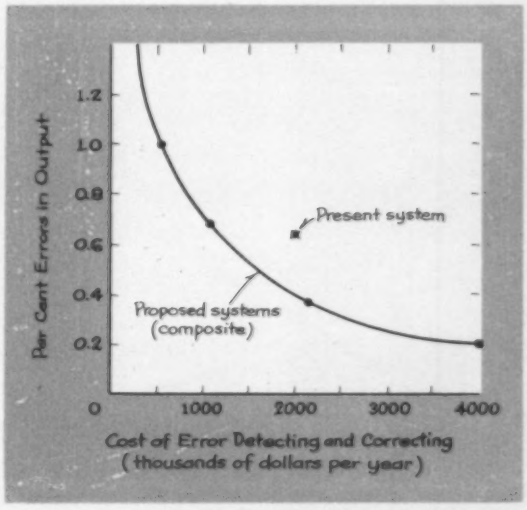


Fig. 6—From investigation of various alternate systems it is possible to prepare composite curve which establishes cost of error control. From such a curve, management can identify price they must be willing to pay to obtain a given error rate in data processing.

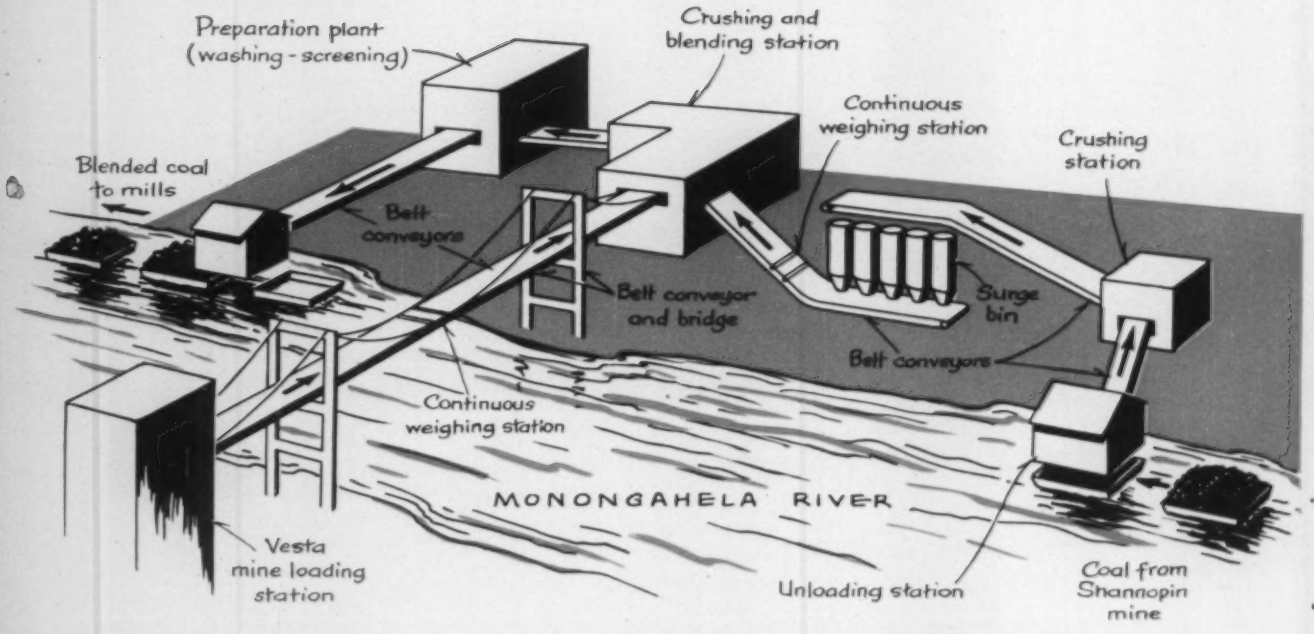
If the curve is for errors in credit sales, and therefore in statements to customers, management may pick a low error rate even at a higher cost. If the errors would only affect management reports used for forecasting, they may pick a lower cost point and accept the errors since the forecasts will be only approximate in any case.

As will be shown in the second and concluding part of this series, which will appear next month, once the cost point is established the systems design can be completed.

AUTOMATION TODAY

AUTOMATIC PROPORTIONING SYSTEM

BLENDS COAL FROM TWO SOURCES



1 Schematic diagram of coal preparation installation where coal from two sources is mixed and treated. Coal from a mine across the river from the plant is delivered on a conveyor supported by a suspension bridge. A continuous weighing station associated with this conveyor senses instantaneous flow rates and also indicates total tonnages passed. Coal from an upstream mine is brought in by barges and picked up at an unloading station. From the unloading station the coal is conveyed to a crusher and on to a series of surge bins. Belt feeders in the surge bins deliver the coal to an inclined conveyor that terminates at a crushing and blending station. The latter station receives coal from both sources. The inclined conveyor is also equipped with a continuous weighing station. Electrical signals from this station and from the weighing station on the mine conveyor are combined at a control point, and act to provide mixing of the coal from the two sources in a predetermined proportion. Control is effected by varying the speed of the surge bin feeders. From the crushing and blending station the coal is conveyed to a preparation plant where it undergoes additional processing including washing and screening. Prepared coal is then conveyed to a loading point, placed in barges, and taken to mills downstream.

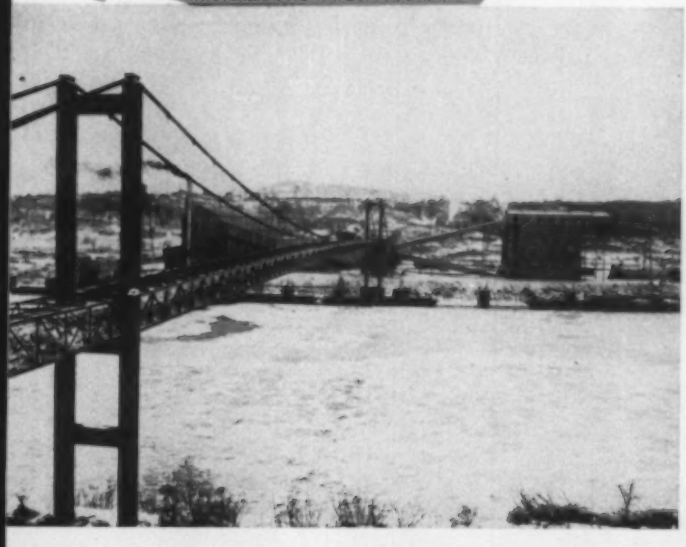
CONTINUOUS PROPORTIONING of metallurgical-grade coal from the Vesta and Shannopin mines at East Fredericktown, Pa., is performed automatically as a part of a preparation and barge-loading operation. The blended coal is transported by water to the Aliquippa and Pittsburgh, Pa., plants of Jones & Laughlin Steel Corp., where it is used in the production of coke.

Prior to installation of the continuous proportioning system, coal from both the mines was transported down the Monongahela river by barges directly to the mills. It was decided that the entire operation could be streamlined and performed more economically by mixing the outputs of the mines at the preparation plant, and then transporting the mixed coals by barge to the mills. Following this decision, engineering specialists were engaged to design the necessary facilities and install them at the East Fredericktown site.

Automatic weighing and proportioning equipment was required, and after investigating several possibilities, an electronic system engineered and built by the Trans-Weigh Co. was selected and installed. Equipment used includes strain gage load cells, tachometer generators, recording instruments, and integrating and totalizing devices.

2

View of Jones & Laughlin Corp. coal preparation plant from Vesta mine end of bridge. Coal from Shannopin mine is stored in surge bins in structure to right of bridge. Preparation plant is located at left.



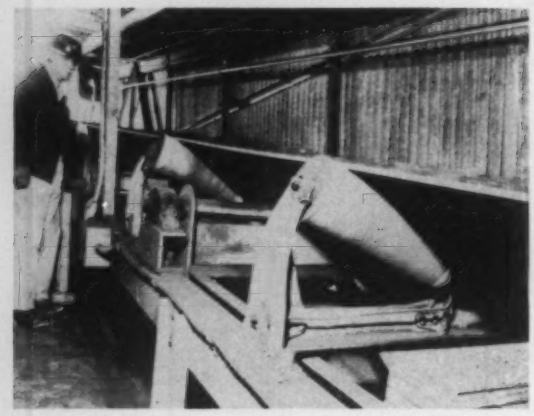
High-volatile coal at the Vesta mine is unloaded into an underground hopper by two rotary dumps. After initial screening and crushing, an apron feeder transports the coal above ground at an average rate of 1300 tons per hour. The coal is then carried on a conveyor supported on a suspension bridge that spans the river. This conveyor, approximately 2000 feet long, terminates at a crushing and blending station where the coal from the two mines is mixed.

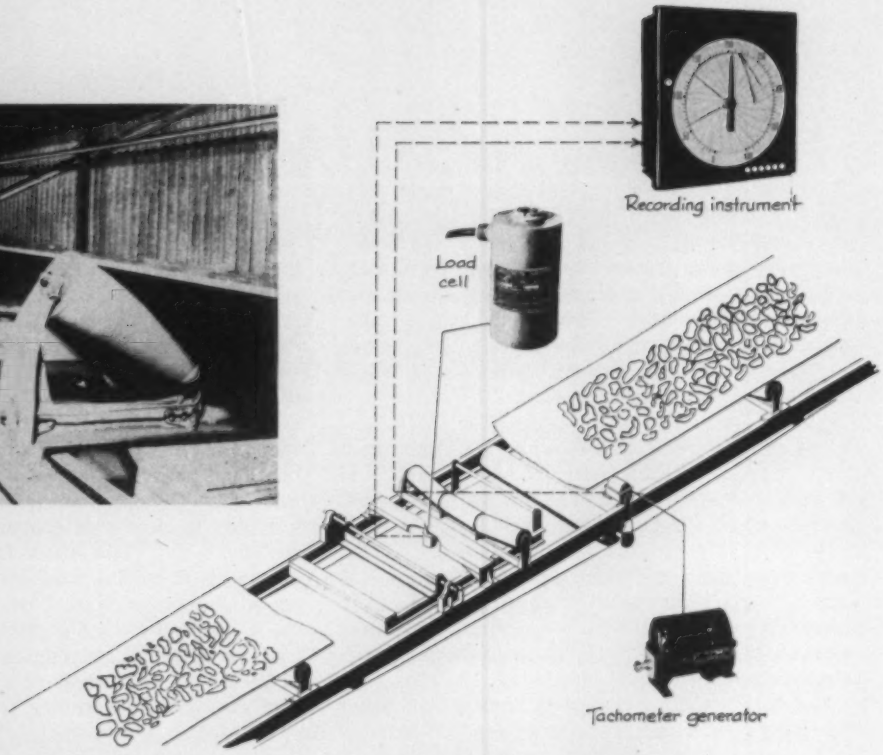
Rather than provide extensive storage capacity for coal from the Vesta mine, which would provide a means of controlling distribution, it was decided to accept an uncontrolled flow rate from this source. As a result, flow variations of 10 per cent occur often over periods of about 10 minutes, and peaks of 25-30 per cent occur occasionally. The control problem, therefore, became one of varying the feed rate of coal from the Shannopin mine to follow these variations. Several months of operation of the automatic proportioning system have shown it capable of delivering properly blended coal in spite of the magnitudes of flow variations experienced.

Coal from the upstream Shannopin mine is unloaded from barges and transported by belt conveyor to a series of ten surge bins having a total capacity of about 5000 tons. Ample storage capacity was chosen to permit two-shift operation of the preparation plant with one-shift unloading of the barges. Since there is always excess coal available, accurate proportioning can be accomplished by controlling the flow rate of the Shannopin in proportion to the Vesta coal.

Each surge bin is equipped with a belt feeder. Speeds of the feeders are controlled by a single rheostat, but up to five of the feeders may be out of use at any one time. A collection belt carries the Shannopin coal from the feeders at an average rate of about 600 tons per hour to an inclined conveyor that in turn transports the material to the point where the two flows join. The resulting mixture of Vesta and Shannopin coals is then conveyed to the preparation plant for final processing. From the preparation plant, the processed coal blend is conveyed to a loading point where it is placed in barges for delivery downstream to the mills.

The weighing and proportioning system solves the problem of providing a uniform mixture. Since it operates automatically, operators do not have to switch to manual control when stopping or starting the conveyors. Location of a flow recording and integrating instrument in the superintendent's office permits simplified supervision of the system. This instrument monitors flow from the Vesta mine, and provides a means of checking over-all system operation.





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Basic elements of continuous weighing station include a load cell, a tachometer generator, and a recording instrument. Load cell measures weight of coal passing over a short section of the belt. Tachometer generator, driven by return portion of continuous conveyor belt, provides signals indicative of belt speed. Weight and speed information thus obtained is fed to recording instrument that indicates and records instantaneous flow rates. An integrator in this instrument also permits readout of total tonnages passed in a given interval of time. The weighing station for the Vesta mine flow is located part way across the suspension bridge; that for the Shannopin mine, shown, is placed along the inclined conveyor that receives coal from the surge bins. Distances of each weighing station from the crushing and blending station are such that the time lags between sensing of weight and dumping of coal into the latter station are approximately equal. Thus, when the Vesta flow rate varies, corresponding changes in the Shannopin feed rate take effect to maintain desired mixing ratio at the junction point for the two flows.

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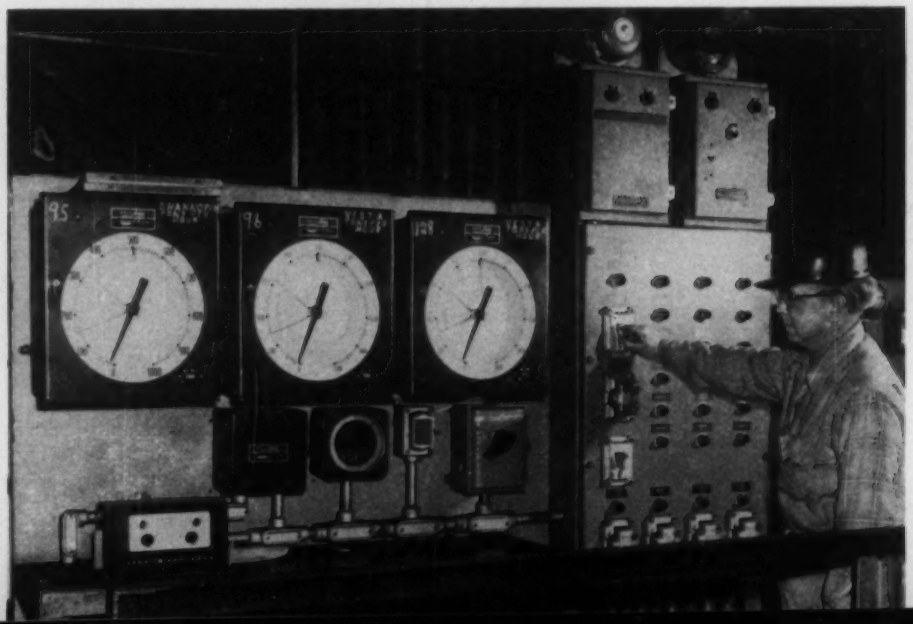
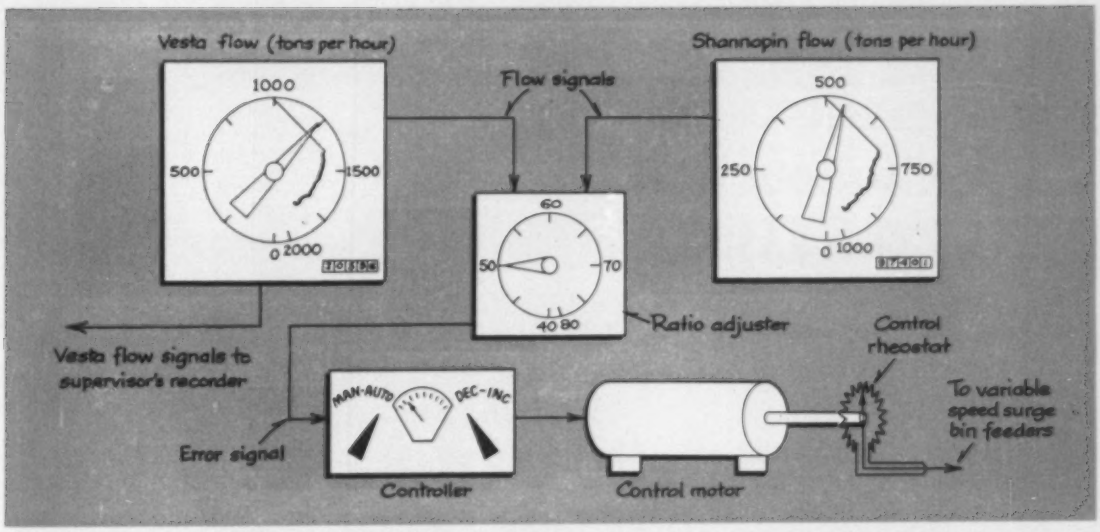


Master control panel set up in the vicinity of the crushing and blending station contains recording instruments and controls that regulate mixing of coals from the two mine sources.



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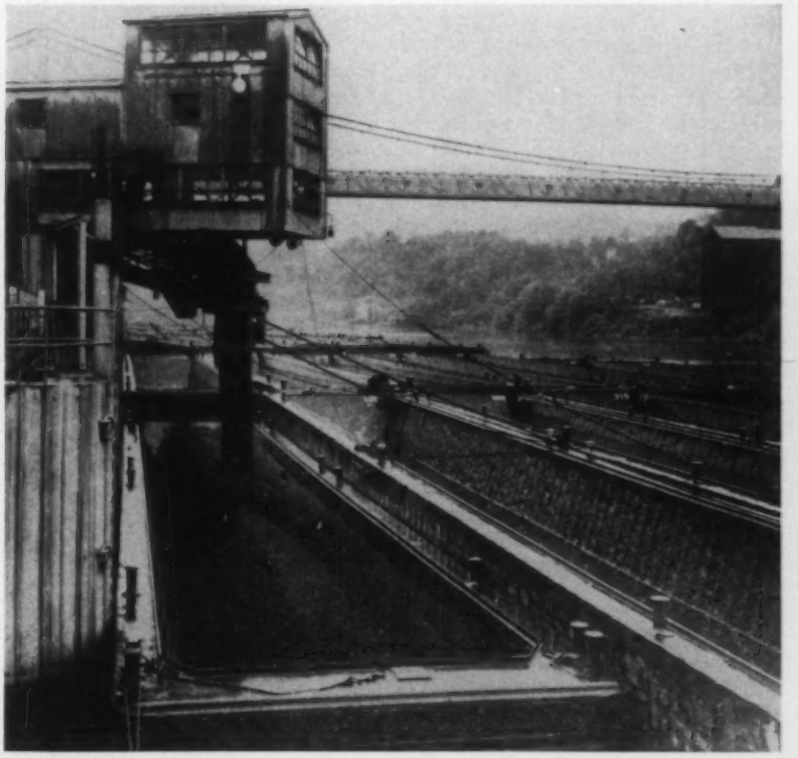
Simplified block diagram of control setup illustrates manner in which speed of surge bin feeders is varied to maintain desired proportionality between coals from two sources. An operator presets the desired ratio of Shannopin to Vesta coal flow by adjusting the dial of a ratio adjuster. The latter device receives flow signals from the recorders proportional to actual, measured feed rates. The measured and preset feed rate signals are then compared by the ratio adjuster. The difference is an error voltage which goes to a controller. The controller, through a motor and rheostat, then increases or decreases the speed of the feeders to bring the error voltage back to zero, which occurs when the proportions are correct. Peaks and valleys in the flow rate of coal from the Vesta mine are thus followed automatically by variations in speed of the surge bin feeders supplying Shannopin mine coal.



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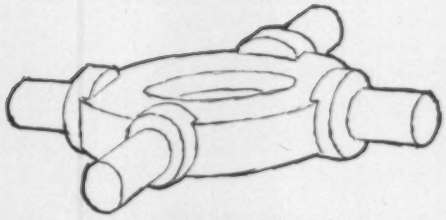
View of the loading point where blended and prepared coal is loaded into barges for transport to mills downstream. Extent of operation is indicated by number of empty barges waiting to be loaded. On the average, 1900 tons of coal per hour are blended and treated during operation of the preparation plant.

SYSTEM CLEANS AUTO PARTS ON PRODUCTION LINE BASIS



CLEANING machined and heat-treated forgings preparatory to grinding them is accomplished on a continuous production line basis in the midwestern plant of an automobile parts manufacturer. Spiders, used in steering gear assemblies, are automatically handled into and out of Wheelabrator Corp. equipment that tumbles and blasts them with abrasive particles. A complete automatic cycle includes loading, cleaning, and unloading.

Parts are released from a large accumulator bin to an automatic loader associated with the machine, *Fig.* 1. Strain gage sensors on the loader provide an electrical signal when a predetermined weight of parts has accumulated in a skip hoist. A pneumatic cylinder then closes the bin gate, stopping the flow of parts. If the cleaning machine is empty and standing open, the loader is activated automatically, *Fig.* 2. Limit switches prevent opening of the bin gate when the skip hoist is up. The skip hoist retracts to the loading position after charging the machine. The machine door is next closed, abrasive blasting occurs, and the load is tumbled. After a controlled period of time for cleaning, the abrasive is shut off. Tumbling action continues, however, in order to remove the abrasive from the work area and prevent its escape when the door is opened.

Automatic opening of the machine door initiates reverse action of the tumbler in a manner to discharge the load. The parts fall onto an inclined, cleated steel conveyor that carries them to a vibrator conveyor. The latter unit delivers them to stations in the grinding area. After the reverse action of the tumbler is stopped, the machine is ready to accept another load of parts from the automatic loader.

Use of strain gage sensors on the automatic loader insures that a full load is accumulated each time the bin gate is opened. Thus, the Wheelabrator unit will not be operated with less than a full load due to interruptions in the supply of parts. This provision reduces wear of the machine, prevents wastage of power, and reduces deterioration of the abrasive particles.

Installation of cleaning equipment in production lines represents a departure over past plant practice of using centralized cleaning facilities. A total of 11 Wheelabrator units are distributed throughout the steering gear assembly production line.

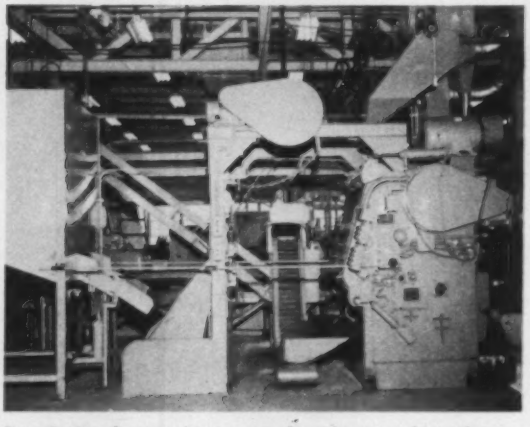


Fig. 1—Production line setup for cleaning forged, machined, and heat-treated spiders used in steering wheel assemblies includes supply bin, automatic loader, and cleaning machine.

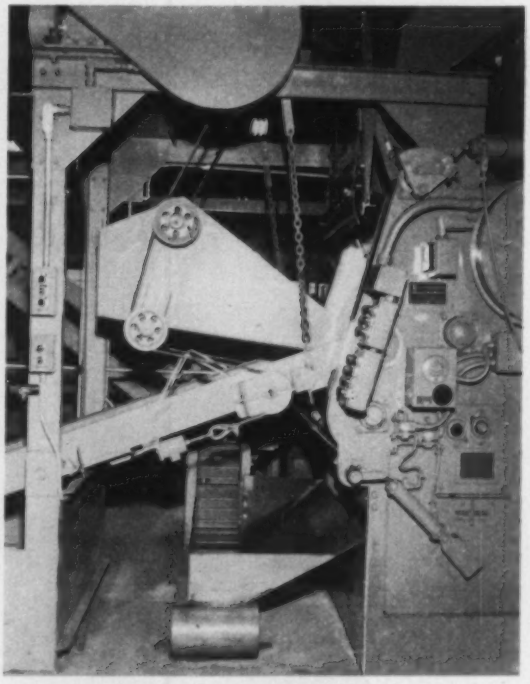


Fig. 2—Automatic loader charges cleaning machine when a predetermined weight of parts has accumulated in loader bucket. Strain gage sensors on loader insure that only full machine loads are processed.

Industry is constantly on the alert for new ideas in handling and assembly of small, discrete parts. By applying the principle of operation of an old style washer wringer, the assembly of fine magnet wires and tiny ferrite cores for computer memory systems has been upgraded from a tedious hand threading operation to a cost-saving mechanized one.

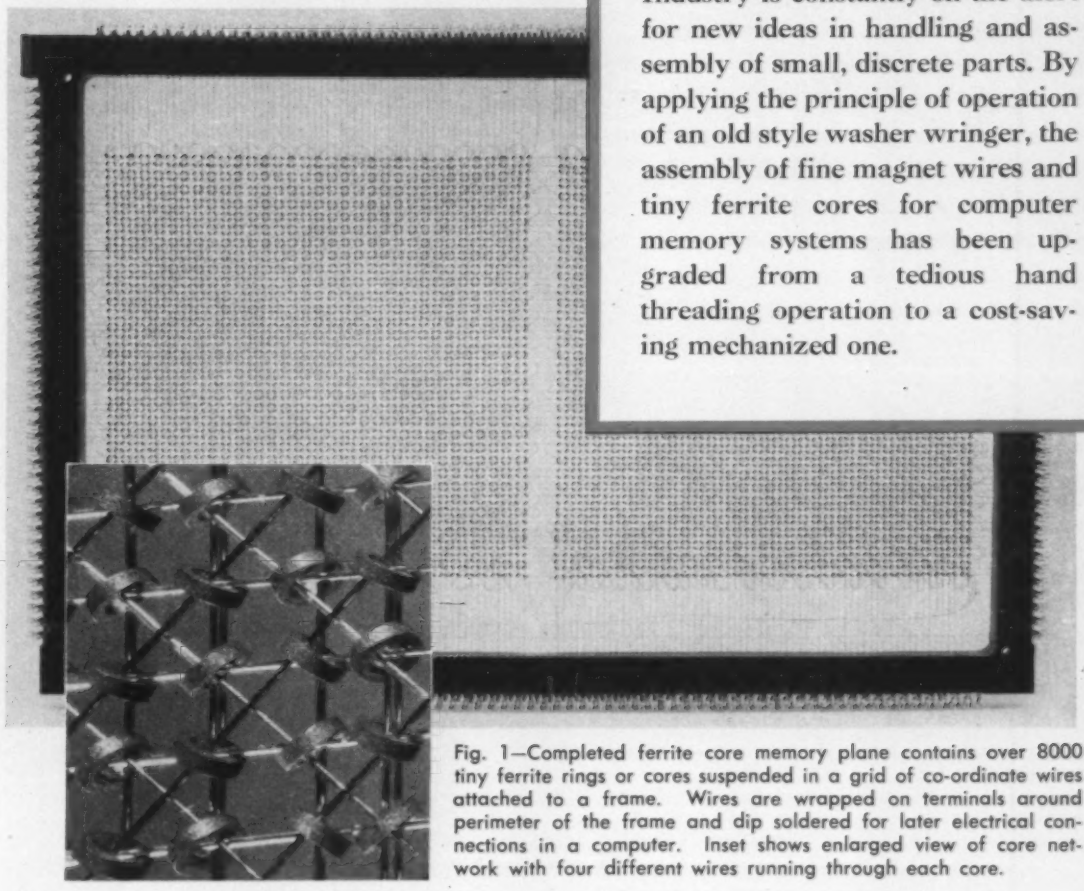


Fig. 1—Completed ferrite core memory plane contains over 8000 tiny ferrite rings or cores suspended in a grid of co-ordinate wires attached to a frame. Wires are wrapped on terminals around perimeter of the frame and dip soldered for later electrical connections in a computer. Inset shows enlarged view of core network with four different wires running through each core.

WIRE INSERTING MACHINE

MECHANIZES CORE PLANE ASSEMBLY

By **WALTER P. SHAW**
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A FUNDAMENTAL part of any modern electronic computer is the section used to accumulate and store data for later use in solving problems. Over the years many different types of mechanical and electronic storage units have been employed as computer memory elements. These have included magnetic drums, tapes, cathode ray tubes, and mercury and nickel delay lines. Although entirely suitable for some applications, these devices limited the development of high speed computer systems since their access speed for the insertion and retrieval of data was restricted by their complexity of operation. In addition, as the need for storage of millions of bits of information increased with modern day computer techniques, space considerations became critical because of the space required per bit of data with these devices.

The search for better and faster data storage methods led to the development of magnetic core matrices which consist of thousands of tiny ferrite core elements suspended in a grid of co-ordinate wires attached to a frame. The installation space required for magnetic core storage systems is small compared to other storage techniques, and access time to store

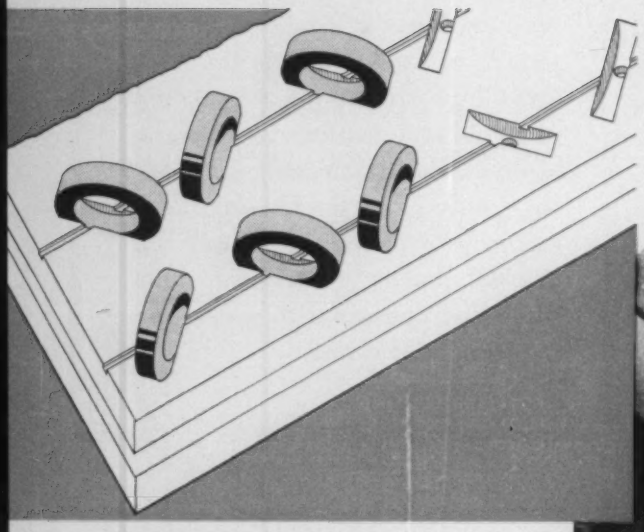

Fig. 2—Sketch shows the plastic matrix used in the assembly of core planes. Loading of cores into matrix is accomplished by mounting the matrix on a vibrating vacuum manifold. Loose cores vibrate around on the surface of the matrix until they fall near a cavity. Vacuum applied through the hole in the bottom of each cavity literally sucks the cores into the cavity.

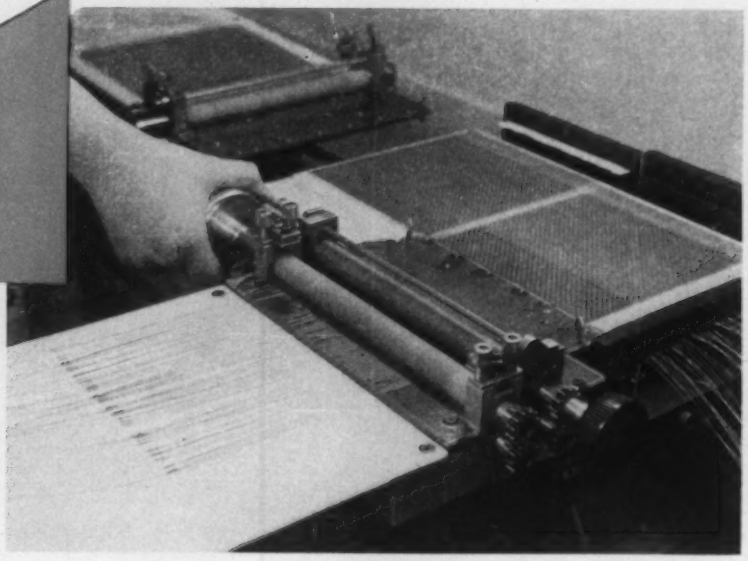

Fig. 3—This unique core threading machine threads as many as 80 rows of cores at one time. Previously, the core threading was a manual job requiring a keen eye and considerable dexterity on the part of the assembler since each row of cores was individually threaded. Roller assembly in the foreground threads one wire in each core along the *Y* axis of the frame, and a similar unit in the background threads wires along the *X* axis.

or retrieve bits of data is instantaneous. In addition, magnetic core systems offer many plus values when compared to other types. A core memory does not consume any power to provide its static memory. A pulse of power is only required to switch a core from one condition to another, but not to hold it in that condition. Core memory systems are permanent, or nonvolatile systems, and they do not lose their data if power is turned off or accidentally lost. Since their operation does not depend upon physical motion, they do not wear out.

While the use of ferrite core memory planes has become an integral part of high speed, modern electronic computers, their space-saving attribute—the tiny ferrite cores—has required costly and laborious hand assembly methods which do not lend themselves to production line techniques. In order to reduce the production costs and eliminate the hand assembly techniques, the Data Processing Machine Assembly & Methods Engineering Dept., International Business Machines Corp., developed a time-saving mechanical device for use in threading the cores.

▶ Manual Assembly Methods

A ferrite core memory plane, *Fig.* 1, is made up of over 8000 cores. Each core is traversed by four different wires—one wire on the *X*-axis, two wires on the *Y*-axis, and the fourth wire threaded diagonally at a 45 degree angle to the *X* and *Y* axes. The manual method of assembling the cores on the four coordinate wires demanded a keen eye and considerable dexterity on the part of the assembler for each wire is only about twice the thickness of a human hair. First efforts to mechanize this operation led to the development of a special matrix to hold the cores during threading. This matrix is a plastic plate having cavities in which individual cores are held by a vacuum applied through a small orifice in the bottom of each cavity. For loading operations, the matrix is mounted on a vacuum manifold which in turn is affixed to a vibrator. Loose cores are dumped on the surface of the matrix and are vibrated until they fall near an empty cavity. The applied vacuum literally sucks the core into the cavity and holds the core during the subsequent threading operations.

After a matrix was filled with cores in each cavity, a piece of hypodermic tubing was used as a needle to thread through the centers of a row of cores. Then, a piece of 34 gage insulated magnet wire was stripped of insulation on one end and inserted approximately one or two inches into the hypodermic tubing. The opposite end of the tubing was grasped on the other side of the matrix, and the needle and trailing wire pulled through the cores. Friction between the wire and the interior of the tubing held the wire as it was pulled through the cores. Once

through the cores, the wire was held and the needle pulled off and rethreaded for the next row of cores.

▸ Mechanization Program

In order to reduce the cost of this hand operation and eliminate the tedious job of threading the tubing approximately 192 times for each core frame, IBM methods engineers embarked on a program to mechanize the operation as much as possible. One of the first things they noticed was that when the ferrite cores were accurately aligned in the matrix by the vacuum, no manual guidance of the needle was required since the cores themselves acted as guides. This indicated that the needles could be propelled in gangs through the cores, instead of individually, with the addition of a suitable mechanical drive unit. A new matrix to hold the cores during threading was made, *Fig.* 2, and differed from the original by having grooves through the cavities along one axis. However, these improvements did not eliminate the worst part of the operation which was threading the needles with the fine magnet wire.

There appeared to be two general approaches to alleviate the constant needle threading problem. One approach was to develop a needle threading device, and the other was to use a continuous wire so that needle threading could be eliminated after an initial threading. After some experimentation, the continuous wire method was selected as the most attractive solution. However, its selection introduced two new problems—namely, how to push the flimsy 34 gage wire through hypodermic needles up to 19 inches long and how to strip the ends of the wire for soldering.

▸ Threading Machine

To solve the first problem, efforts were expended on devising a machine to drive gangs of threaded needles through the cores simultaneously. This effort culminated in the design and construction of a needle threading machine, *Fig.* 3, capable of impelling up to 80 hypodermic needles and magnet wires through cores at one time.

The threading machine installs two groups of wires in the core plane assembly. One group of wires is threaded along the *X* axis, and a second group of wires is threaded along the *Y* axis. The final two wires of the matrix are installed manually since they are of one continuous length running through all the cores and do not involve the continual threading of needles.

The threading machine consists of four sets of rollers that drive gangs of needles and wires along two axes of the matrix. Two sets of rollers are arranged to thread the *X* axis, and the other two sets of rollers feed along the *Y* axis. After the wires have been threaded along the axis and secured, the wires are pulled down into the grooves so that the needles from the other axis can pass over the wires without interference.

Cores are loaded into the matrix in the same manner as for the manual method by use of vibration and vacuum. The loaded matrix is then transferred to the threading machine, and vacuum is applied to hold the cores in place. Up to 80 needles are positioned in spaced holes of a guide plate which is aligned so that each hole will guide a needle

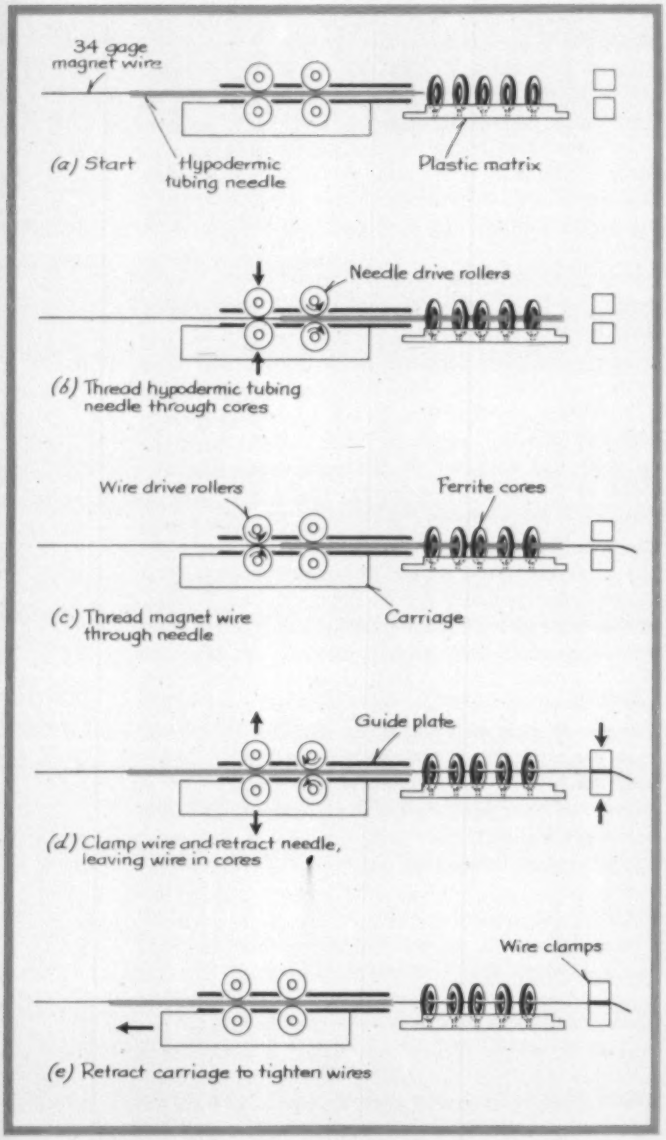

Fig. 4—Schematic shows the threading of one row of cores by the core threading machine. Plastic matrix loaded with cores is placed in machine *(a)*; needle drive rollers impel hypodermic tubing needle through row of cores *(b)*; wire drive rollers thread wire through needle, cores, and clamps *(c)*; clamps are closed to hold wire, and needle is retracted by rollers, leaving wire threaded through needles *(d)*; carriage supporting roller assemblies is retracted to tighten wires, and, on one axis, to pull wires down into slots in matrix *(e)*.

WIRE INSERTING MACHINE

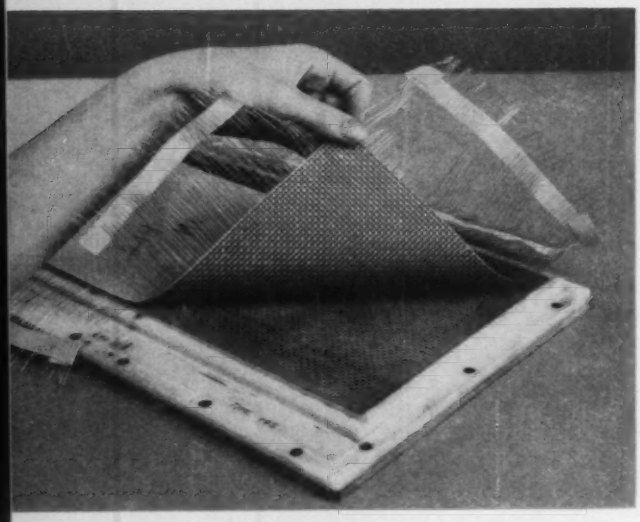

Fig. 5—Finished mat of cores and wires is removed from matrix. A wide sheet of masking tape has been pressed against one side of mat to hold cores in place during subsequent operation of assembling unit to frame. After the threaded wires are wrapped on the frame terminals, additional wires are threaded manually along the Y axis of the cores and diagonally across the cores to complete memory plane.

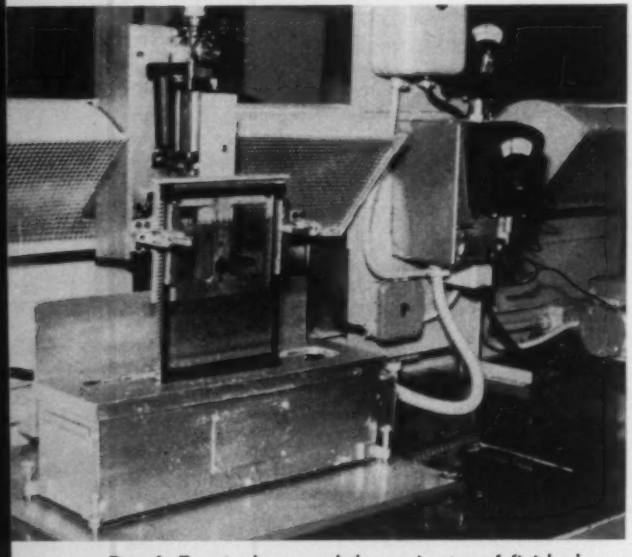

Fig. 6—Terminals around the perimeter of finished core frames are dipped into this solder tank to strip insulation from the wrapped wire connections and to apply a coating of solder. Depth and time of immersion of terminals in the solder are closely controlled to prevent damage to the frames and fragile wires.

through the center of the cores along one row, *Fig.* 4. The needle drive rollers contact the tops and bottoms of the needles through a slot in the guide plate and drive the needles in unison through the rows of cores until the trailing ends of the needles clear the wire drive rollers. This set of rollers contacts the wires through another slot in the guide plate. The fine wires are driven by these rollers through the needles and cores until they emerge on the far side of the matrix and are fed into a wire clamp. After clamping the projecting wires, the needle drive rollers are reversed to withdraw the needles from the cores, leaving each row of cores with a wire threaded through it. The carriage holding the two sets of rollers is then retracted, pulling all the wires taut and down into the slots in the plastic matrix. The operation is then repeated along the other axis of the matrix using a similar setup of drive rollers for the needles and wires. In the core plane illustrated, *Fig.* 1, the plastic matrix is then shifted and another set of wires is threaded on the remaining half of the frame.

After wires have been threaded along the two axes, a strip of masking tape is placed across the wires to hold them in place for removal of the matrix from the machine. The wires are then cut at the leading ends of the needles, leaving the needles fully wired and ready for the next core frame assembly. The frames are removed from the machine, and the matrix of cores and wires is removed from the plastic matrix. This is done by pressing a sheet of wide masking tape over the cores with a sponge rubber pad until the cores are firmly affixed to the tape. The "mat" of cores and wires is then peeled off the plastic matrix, *Fig.* 5.

The remaining problem to be solved was how to strip and solder the individual core assembly wires. The solution to this was found by changing to a different type of insulated wire which could be stripped and soldered in the same operation. Instead of individually stripping the wires prior to threading, an entire core frame was completed, and the wire ends wrapped on frame terminals. Then the terminals were dipped into 900F solder. First attempts to hand dip the frames at the high solder temperature met with immediate disaster in the form of broken wires and warped frames. It was apparent that the new dip-stripping process would require much closer control than the previously used methods of soldering stripped wires. Accordingly, a dipping machine, *Fig.* 6, was built to maintain a preset time and depth of immersion of the terminals within very close limits, and a high quality soldering operation was achieved.

The unique threading machine has eliminated a tedious hand operation and greatly reduced assembly time for making ferrite core plane matrices. The principles of operation designed into the machine are not new, but can be found on any old style wringer washing machine. By applying the squeeze roller principle of the washer, IBM has created a unique device for doing a complicated job, but still has retained a degree of simplicity not commonly associated with an assembly machine for a complex wiring operation.

Fig. 1—Back-to-back arrangement of test benches in circuit development laboratory makes efficient use of floor space. Variety of electrical components and subassemblies can be plugged in at tops of master panels. Larger components and subassemblies are placed on benches and can be interconnected with panel units through jumpers. Panels are supplied with ac and dc power and contain metering and circuit protection equipment.

By R. A. LORDEN
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General Electric Co.
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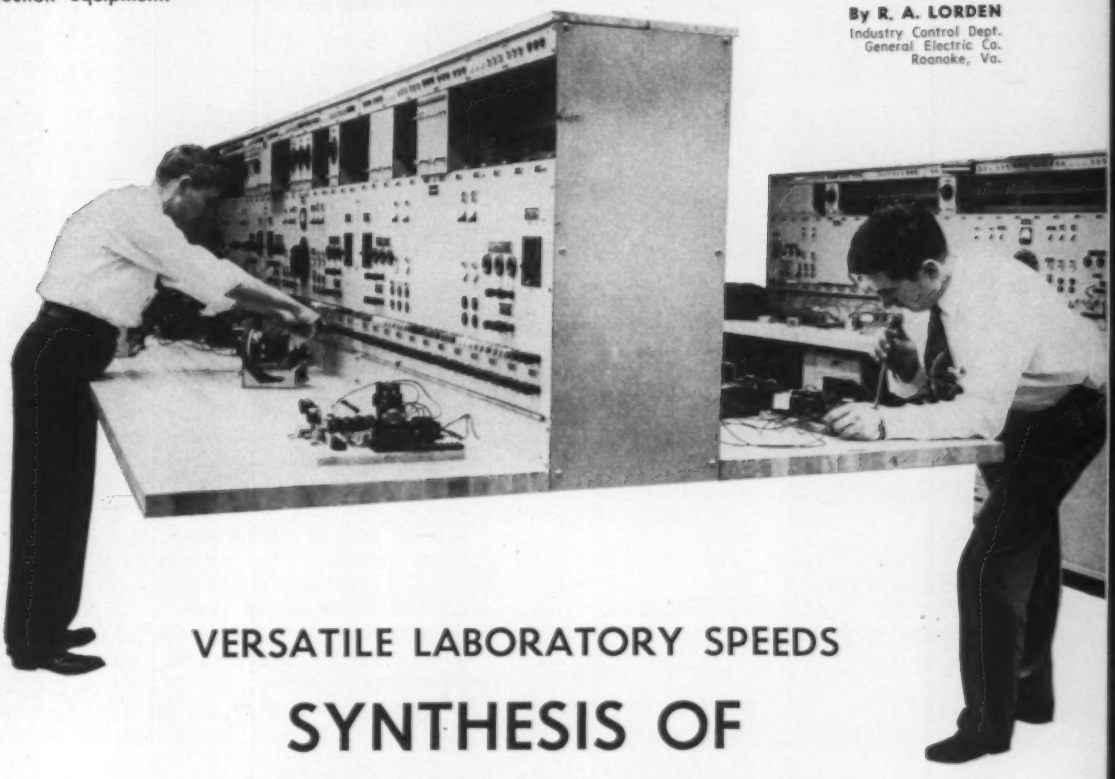

VERSATILE LABORATORY SPEEDS

SYNTHESIS OF CONTROL CIRCUITS

IN ITS QUEST for greater productivity through automation, industry is demanding, and getting, electrical controls that provide the performance, reliability, and accuracy needed to regulate today's high-speed, multifunction machinery. As the complexity of this productive equipment increases, controls become more complex also. New components—static switches, programming devices, and semiconductors—are being applied more and more to such controls. As a result, controls suppliers who use these new components find themselves in a transition period wherein construction and thorough testing of prototype models may be the only way to establish the worth of a given control system. This condition promises to remain until such time as qualitative and quantitative data are established on a par with that available for more conventional electrical components. To minimize the difficulties that exist during this transition, an efficient circuit development laboratory is essential in helping to meet industry's current needs.

▶ Objective—Immediate Results

A circuit development laboratory differs greatly in concept from a research or general engineering laboratory. The function of the latter is to investigate problems of a broad technical nature, the solutions of which need not have immediate commercial applications. The circuit development laboratory, on the other hand, exists for the sole purpose of developing new commercial products and improving existing products in a minimum of time.

In spite of their different aims, however, the two types of laboratories are often combined physically. This arrangement makes available to each group special testing facilities—mechanical shock and vibration testers, humidity chambers, oscilloscopes, and other electrical instruments—without duplication. Model shop facilities may also be made available on a joint-use basis.

At the Roanoke, Va., plant of General Electric Co., a circuit development laboratory has been

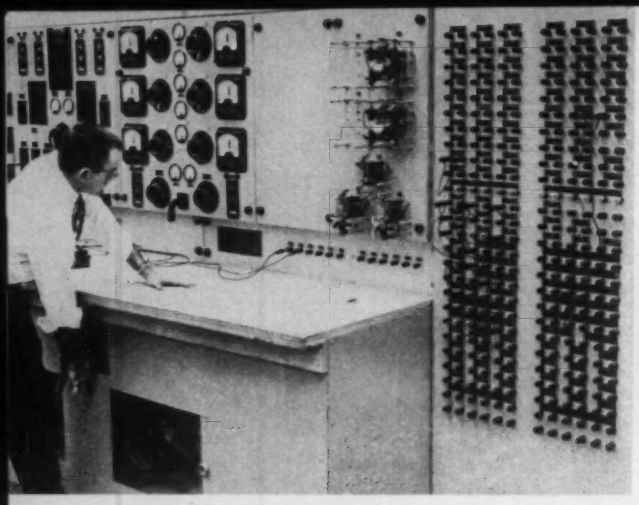

Fig. 2—Test bench for synthesizing closed-loop regulators for motor-generator drive systems. Driven dc motor is mounted under bench and may be loaded by a Prony brake arrangement. Control components have leads brought to patchboard panel at right for rapid connection into regulator circuits.

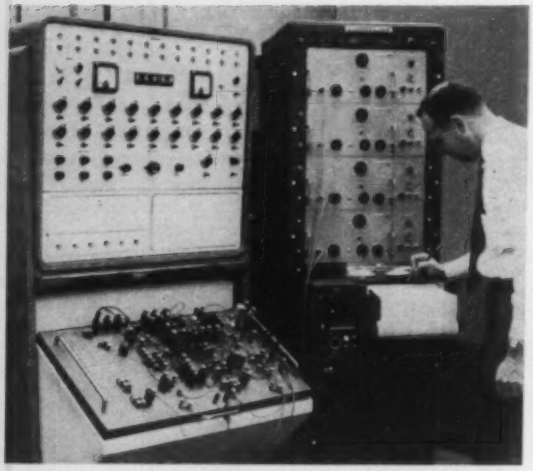

Fig. 3—Analog computer is used when full-scale working model of regulator cannot be set up in laboratory. Data such as mechanical and electrical time constant information are preset into computer. Regulator performance is checked on chart recorder.

set up for use by a design section of the Industry Control Dept. This installation is an example of an efficient layout for the rapid development and testing of electrical control circuits.

It is the responsibility of the design section using this laboratory to combine available, proved components into new electrical regulating controls that will be commercially profitable. Given this objective, the circuit designer plans and executes all of the steps necessary to develop a finished, marketable product. Assuming that a preliminary elementary circuit diagram has been worked up and component values have been selected, his next step is to build and test a prototype in the circuit development laboratory. Testing includes checking the stability, speed of response, regulation, and reliability of the device.

Efficient Layout

With the emphasis on speed of accomplishment, the laboratory is arranged and equipped to enable rapid assembly and testing of prototype circuits and to permit frequent experimental changes. For example, test benches, *Fig.* 1, contain master panels into which can be plugged a variety of circuit variables mounted on subchassis—rheostats, transformers, capacitors, relays, etc.—depending on the circuit to be synthesized. Leads from these elements are brought to binding posts and jacks at the front of the panels at a convenient height above the table tops. This provides added flexibility in that bench-mounted instruments and units too large to be plugged into the panel can be combined into circuits that include plug-in units.

Alternating and direct current is available at each master panel, at 115/230v ac and 125/250v dc. Meters, variable autotransformers, electrical outlets, fuses, and circuit breakers are also panel-mounted where needed. All of the master panels can be electrically connected to one another or to any other equipment in the laboratory by simply plugging jumpers into a transfer panel.

The arrangement of the test benches, with back-to-back master panels, is such that a maximum of bench area is available for a given floor area. Several problems can be worked on simultaneously with a minimum of distraction to personnel.

A test bench for synthesizing and testing closed-loop regulating circuits for motor-generator drives, *Fig.* 2, is set up in another part of the circuit development laboratory. This arrangement is used to develop and prove in regulating devices for control of speed and torque of dc motor-driven systems. Such drives are used throughout industry.

A patchboard panel located adjacent to this test bench enables rapid connection of a variety of control components into regulating circuits. The actual components are mounted behind the patchboard or in an adjoining motor room, with leads brought to the front of the patchboard panel. Complete metering is available on the test panel to enable study of the magnitudes of all voltages and currents involved. Driven motors are mounted beneath the benchtop, and can be friction loaded by means of a Prony brake which is adjustable from the front of the test bench.

In many instances, a full-scale working model of a regulating system cannot be set up in the laboratory. This applies to controls for power shovel, mine hoist, and large co-ordinated steel rolling mill drives. In these cases, over-all regulating efficiency can be determined with an analog computer, *Fig.* 3. Necessary data, including mechanical and electrical time constant information, are preset into the computer. A recording device makes a permanent record of the regulator performance and shows the effects of varying the component values or operating conditions.

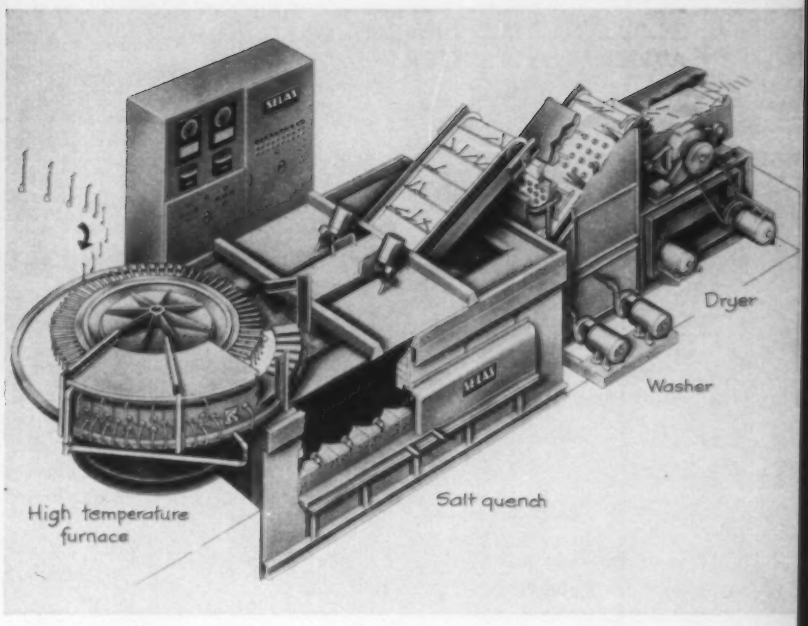

Fig. 1—Representation of integrated heat processing unit developed by Selas Corp. of America for use by International Business Machines Corp. Product being processed is electric typewriter type bar stamped from steel. Parts are heated in furnace, quenched in salt bath, rinsed, and dried in a continuous operation.

MECHANIZED AUSTEMPERING SYSTEM

PROCESSES TYPEWRITER PARTS

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Decentralization of heat treat facilities, in keeping with the trend toward more in-line operations, can result in major economies. Modern, efficient furnace equipment makes it possible to locate operations where good engineering practices dictate that equipment should be located.

PLANT moves are traditionally an occasion to review existing practices and introduce production improvements. When International Business Machines Corp. moved its typewriter manufacturing operation to a plant near Kingston, N. Y., the company determined to increase efficiency by automating processes wherever practical. Type-bar austempering was one of the processes selected for increased mechanization. Production engineers at IBM worked with process development engineers of Selas Corp. of America in improving the austempering process.

The parts treated are type bars for electric typewriters. The typical bar is about 4⅝ inches long, 9/32 inch wide, and 0.040 inch thick stamped from AISI 1040 steel and bent at one end, *Fig.* 1. Type faces are subsequently soldered to the type bars, thereby forming the units that produce the impres-

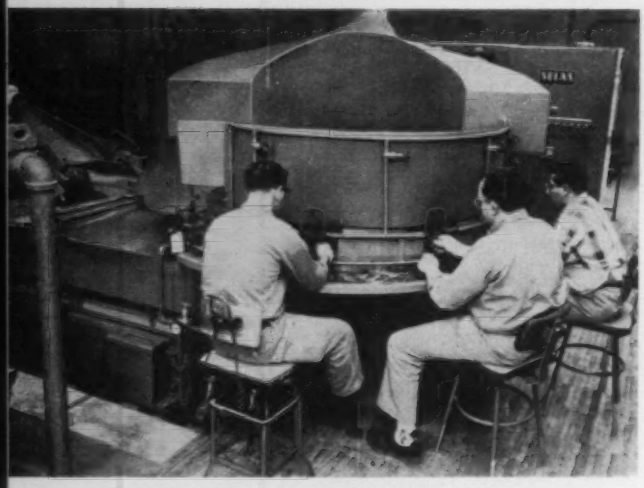


Fig. 2—Type bars are individually loaded onto fixtures by operators. This high temperature furnace unit is placed on a hardwood floor—a measure of the efficient control of the heating operation.

sion on paper during typing. Since all the type bars in a typewriter form a segment of a circle when at rest, but each must strike the paper in a vertical position, the bar is press-formed to a different angle for each character. At least forty-two such shapes are required for each IBM electric typewriter.

The high operating speed of electric typewriter type bars requires a hard, tough structure and a flat shank. These requirements are embodied in the specifications for hardness (Rc 42-44) and flatness (shank flat ± 0.001 inch). Required hardness without warping is developed by heating the parts for hardening, and quenching them in an elevated temperature bath to permit an isothermal transformation to take place (austempering).

The process itself is not new to the manufacture of these products. Type bars were formerly treated at about the current production rate, using two salt bath furnaces—one for high temperature austenitizing and the second for isothermal quench. This equipment required five men for operation, and involved considerable maintenance time, expensive fixture replacement, and large quantities of salt plus other supplies.

In developing new equipment, it was determined that a fixed time of treatment was required only in the isothermal quench and that the initial heating and subsequent cleaning operations could be shortened without adversely affecting the quality of the workpiece. It was therefore decided that the temperature of type bars should be initially raised above the austenitizing temperature by passage through a furnace operating at a high temperature gradient, quenched by quick, direct transfer—without coming into contact with room air—into a conveyorized salt bath maintained at the proper temperature, and then washed to remove the salts. Bars were to be delivered at the end of the process completely treated, clean, dry, and at room temperature.

Furnace Features

The basic concept of the Selas heat treating system, with high temperature gas furnace, mechanized salt bath quench, and high speed automatic wash and dry sections, is shown in *Fig.* 1. The heat treating system forms a logical segment of the work flow. It is located, not in a separate heat-treating shop, but in the metal-working area close to the press which stamps out the workpiece. Parts handling is simplified accordingly. Efficient heating with minimum heat loss to the surrounding area makes this arrangement possible. High thermal efficiency is indicated by the fact that the high temperature section of the machine is mounted directly on a hardwood floor.

Handling is completely automatic after manual loading, *Fig.* 2, of the type bars onto the support fixture of a horizontal pinwheel conveyor equipped with heat resistant chrome nickel alloy fixtures. A type bar is loaded in the vertical position at the extreme end of each radial pin on the conveyor and is carried from the loading area into the high temperature furnace. This furnace is shaped to conform to an arc of the circle through which the type bars travel. Each type bar is heated to 1550 F in 25 sec, then is released from the fixture to drop through a tube into the salt bath.

The high temperature furnace is fired by Selas

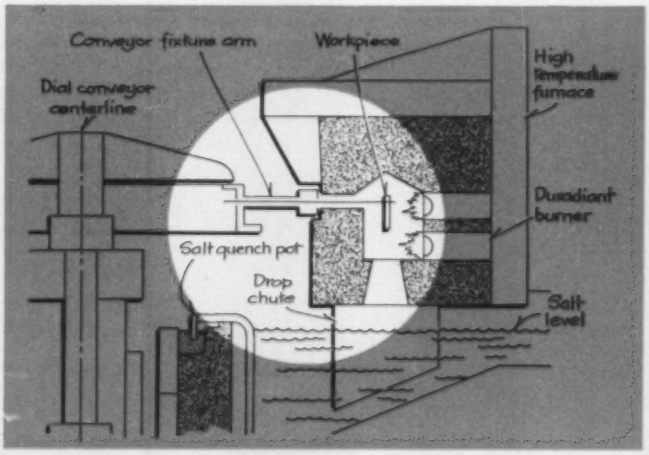


Fig. 3—Individual type bars are heated to 1550 F in 25 sec as they are exposed to directed heat from bank of burners. Burners are approximately 4 inches from the path of travel of the parts being heated. The bars are automatically stripped from fixture over a drop chute leading to a conveyorized quenching bath.

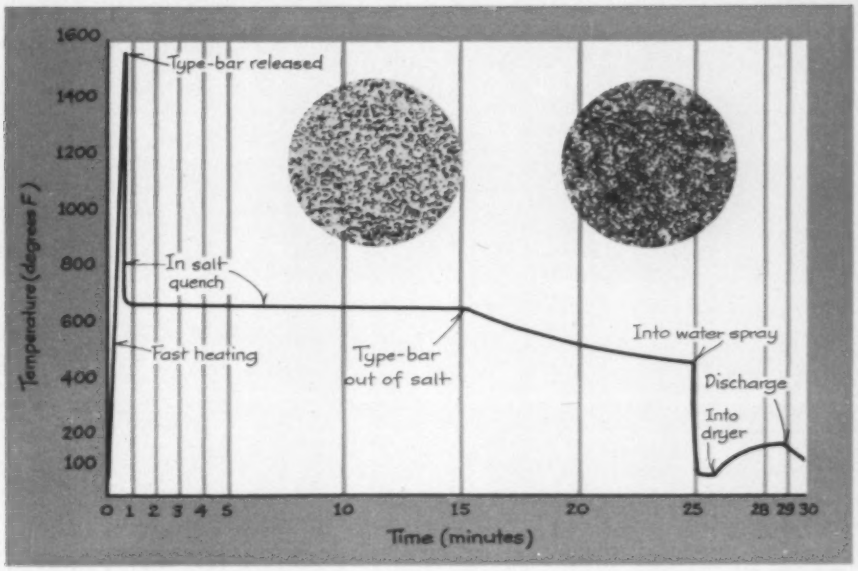


Fig. 4—Time-temperature curve of austempering process as followed by washing and drying operations. Microphotographs (500X) compare structure of steel as received and after the heat treatment.

Duradiant burners set in the outer refractory wall. Each burner consists of a ceramic cup in which a controlled mixture of natural gas and air is burned. The flame wipes the cup, bringing it to incandescence, resulting in high intensity radiation of thermal energy to the workpiece. Combustion is virtually completed within the cup, preventing flame impingement on the workpiece although the burners fire directly at the type bars at a distance of only 4 inches, *Fig.* 3. Burners are placed in horizontal rows in a pattern engineered to produce a uniform temperature throughout each type bar by the time it is released for quenching.

The salt quench furnace, into which the type bars are dropped after reaching 1550 F, is the largest component of the austempering line. The bath is contained in a welded steel pot set into a specially designed furnace. The salt pot is completely enclosed to prevent dangerous splash of hot salt and to minimize heat loss. Heat is supplied by two rows of burners firing at close range, one row on either side of the pot. Twin, propeller-type agitators provide temperature uniformity within 2 F throughout the salt bath.

Type bars are held in the salt bath for 15 minutes, spending about 10 additional minutes on the salt quench conveyor. They then fall through the recirculating water spray to clean off the dried salt, and are carried up a belt-type conveyor and deposited into a dryer. A time-temperature curve for the entire process is shown in *Fig.* 4.

▶ Control Features

Once the furnace is lighted and at temperature, and except for loading the type bars, the operation is fully automatic. A thermocouple in the high temperature furnace chamber controls the initial heating through a recording controller which supplies a signal to a motorized valve modulating the gas-air input rate to the burners. A similar recording controller serviced by a submerged thermocouple, controls the temperature of the salt quench. As a safety feature, another indicating controller is operated from a separate thermocouple in the salt quench furnace to prevent overheating under unusual or abnormal conditions. The temperature control system is completed by an indicating controller which regulates the temperature of the circulating air in the dryer.

Salt bath burners and the dryer burner are spark ignited from the control panel through an automatic purge cycle control, which eliminates the hazard of possible flammable vapor accumulation. All the motors in the heat treating system are started and stopped from a cluster of pushbuttons close to the temperature controls, with pilot light indicators to monitor operation. The motors drive the combustion controller; two water pumps; the furnace, salt, wash, and dryer conveyors; the salt mixers; and the dryer blower.

The results of this operation have been highly satisfactory. The heat treating system is operated by three men instead of the five formerly required for the same production. Dragout of molten salt is substantially reduced while a possible personnel hazard in periodic removal of sludge from the hot salt has been eliminated completely. Downtime has been materially reduced.

This has been accomplished, furthermore, with a reduction in the reject rate and with virtual elimination of scrap. By employing an in-line machine type of heat treating equipment, IBM has moved its austempering from a separate heat treat room to the type bar production area, materially reducing the amount of work handling required.

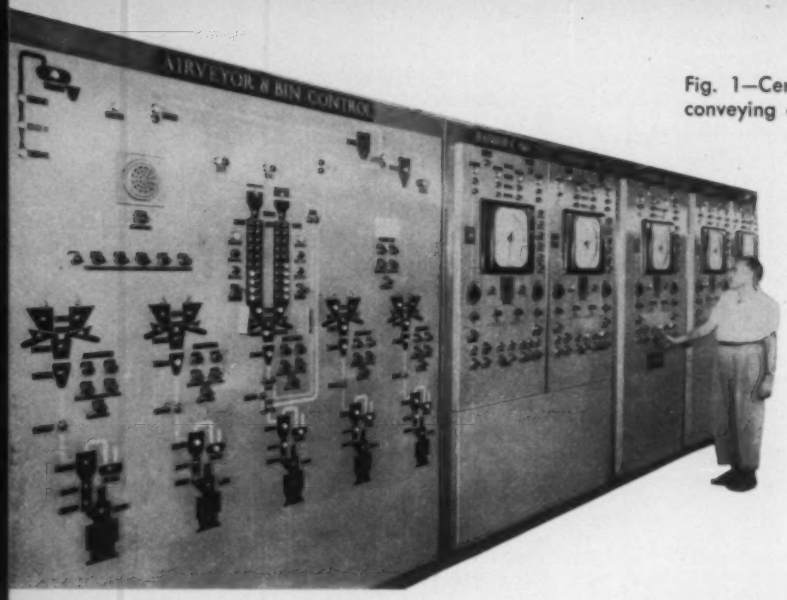


Fig. 1—Central panel in tire plant controls automatic conveying of rubber pellets through preparation steps.

INTEGRATED CONVEYING METHODS FORM

PELLET HANDLING SYSTEM

MODERN PRACTICE in the production of car and truck tires is to supply molding units with compounded rubber in pellet form. Use of pelletized rubber is only possible, however, when suitable handling arrangements are provided. At the Gadsden, Ala., plant of Goodyear Tire and Rubber Co., such pellets are handled automatically by a pneumatic conveying system. The entire handling system can be controlled from a single panel, *Fig.* 1.

When bales of crude rubber arrive at the plant, they are stored and conditioned for production line processes. After conditioning is completed, the rubber is moved by roller conveyors to a Banbury mixing machine, made by Farrel-Birmingham Co. Inc.

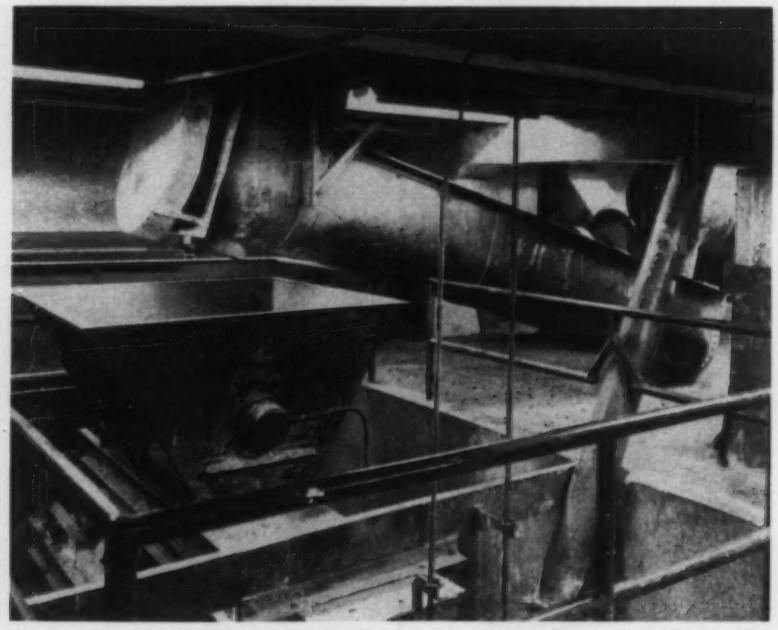


Fig. 2—Integration of various conveying means is indicated by this photo showing a screw conveyor that drops material into a hopper for a belt conveyor which discharges into a pneumatic conveyor that passes upward to the right.

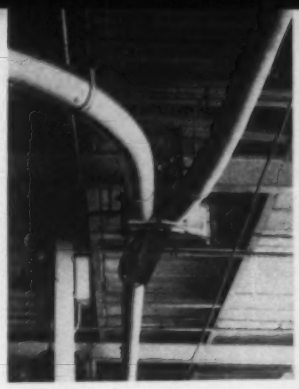


Fig. 3—Valve in the pneumatic conveying line allows the rubber pellets to be moved to a filling point for portable bins or moved to the top of a special stack of bins for storage.

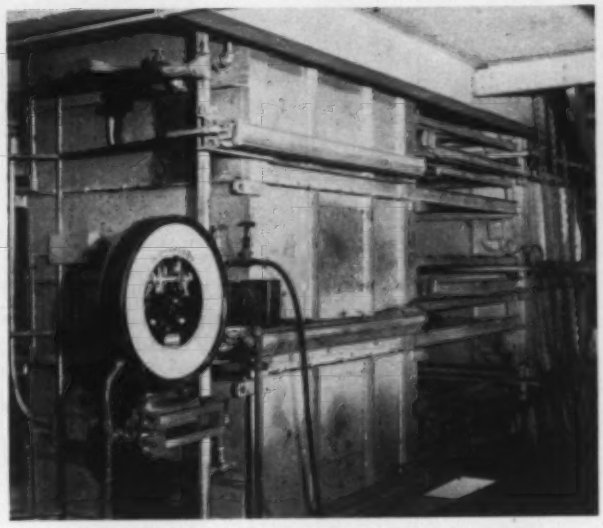


Fig. 4—Since rubber pellets can only be piled to a limited depth, special storage arrangements such as these two stacks of bins are used. Air operated slides separate individual bins and allow controlled quantities of pellets to be progressively dropped from compartment to compartment.

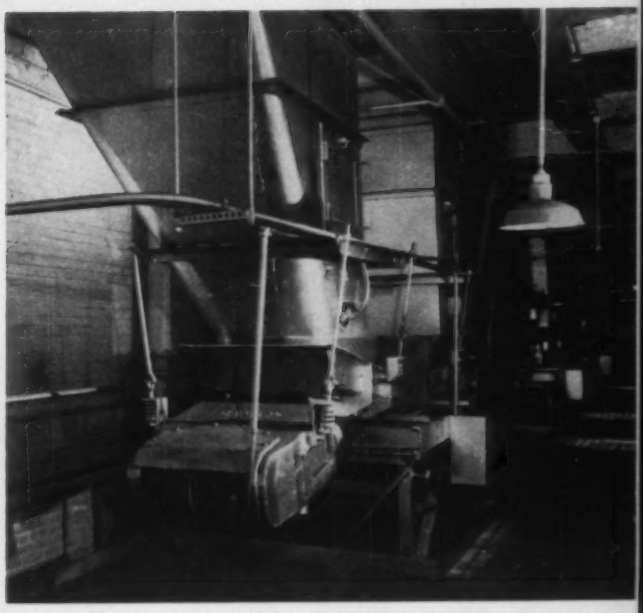


Fig. 5—Still another type of handling device, a vibratory feeder, is used to move rubber pellets to weighing hoppers which feed the Banbury mixers that prepare finished rubber compounds.

An operator selects bales for specific formulation and adds other ingredients directly into the mixing chute.

After the high-pressure mixing operation is completed, the rubber compound is discharged into a pelletizer. The pelletizer operation is similar to that of a giant meat grinder, and the hot, pelletized rubber drops down another chute. A belt conveyor delivers the pellets to a series of screw conveyors for cooling. Here they are slurried in water and chemicals to keep them from sticking together.

The last of these cooling conveyors, *Fig.* 2, discharges directly into a surge hopper which empties by belt feed into a pneumatic conveyor made by Fuller Co., a subsidiary of the General American Transportation Corp. This conveyor carries the pellets up to the ceiling of the second floor. Here, *Fig.* 3, the pellets can go either to a loading station for portable bins or to a system of special stack bins.

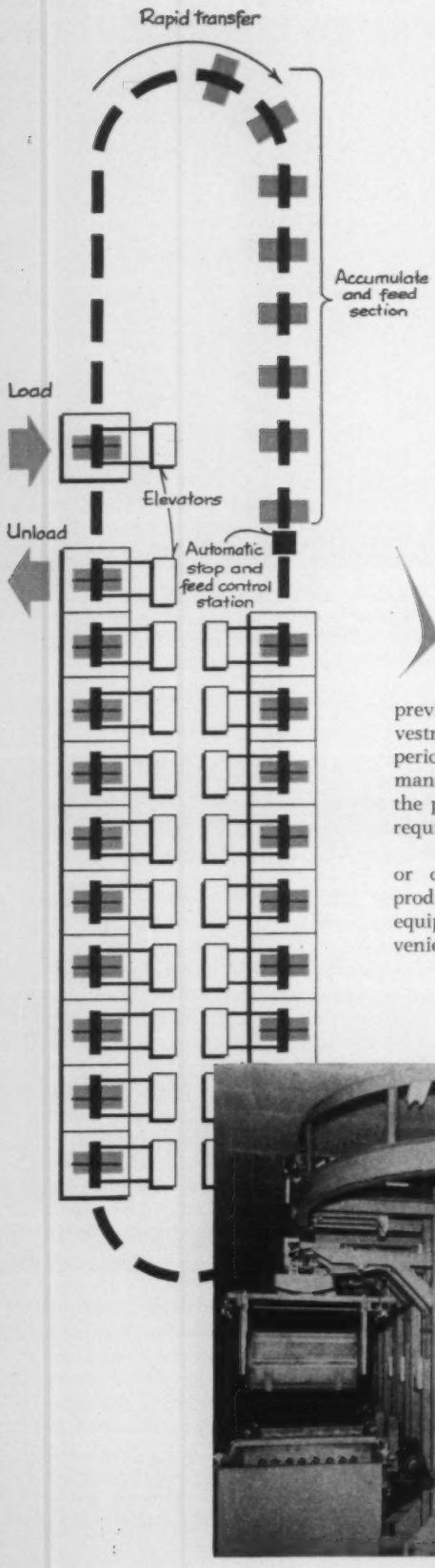
At the loading station for portable bins, loads of pellets are automatically discharged into the waiting bins. Special fork lift trucks pick up the bins and deliver and empty them into chutes in the floor. There are four such chutes, each leading to concentrating hoppers with a weighing arrangement on the floor below.

The special stack bins are a product of Richardson Scale Co. They consist of a series of 10 bins, arranged vertically one above another, *Fig.* 4. Air operated slides separate the individual bins. Pellets are delivered by pneumatic conveyor to a feeder above the top bin. When this bin is full and the bin below it is empty, a flow control switch is actuated automatically, and the bin is discharged.

After a predetermined time interval to assure complete discharge, the bin slide closes and the bin is ready for another load. The same transfer sequence is followed down through the other bins.

Pellets are discharged into surge hoppers. These hoppers are equipped with special switches which call for supplies automatically. Each hopper is equipped also with a stream regulating slide. Pellets are supplied from these hoppers to vibrating flat feeders, *Fig.* 5, built by Syntron Corp. The vibrating feeders deliver pellets to five hopper scales, equipped with double hopper door discharges. Weighed quantities from each hopper are discharged into pickup hoppers from which pneumatic conveyors take the material to finish run Banburys. From these machines, finished rubber compounds are fed to production units.

All of these pneumatic conveyors are of the vacuum type, employing positive pressure exhausters for air supply. Each conveying system is equipped with its own individual bag-type filter, automatic in operation, which provides for 100 per cent visible dust retention. Exhausters and filters are located on the roof.



AUTOMATIC HANDLING SYSTEM

SEQUENCES CARRIERS INDIVIDUALLY

PRESENT-DAY requirements for flexibility in processing are a direct result of the rapid changes both in products and technology demanded by our dynamic and competitive economy. Industry's previous concepts of the economics involved with respect to capital investment in productive equipment and rate of return, based on a fixed period for obsolescence, have been altered seriously. Unforeseen demands for change, either in end products or methods of production, are the principal reason for this. Too often, previously installed equipment requires extensive and costly modification to meet these demands.

In the important manufacturing function of automatic handling or conveying, continual improvements in products, materials, and production techniques emphasize the economic soundness of providing equipment that can adapt to changes at minimum cost and inconvenience. Ideally, such equipment should include self-contained, in-

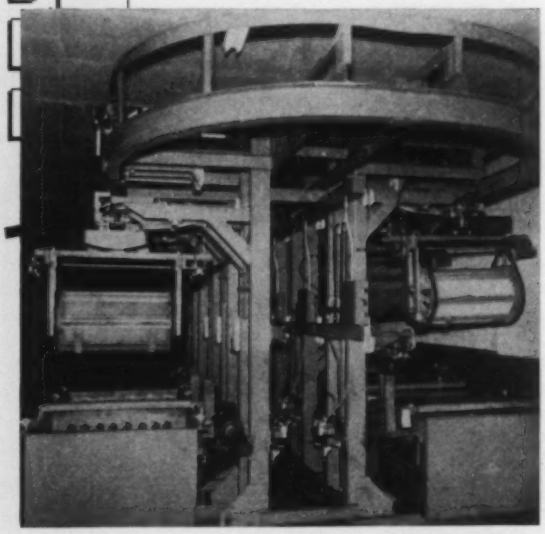


Fig. 1 — Barrel plating installation illustrates application of Abbey Process Automation Inc. handling system. One operator loads and unloads barrels containing up to 200 pounds of parts. Processing, including zinc plating and bright dipping, is automatic. Production rate is 20 barrels per hour.

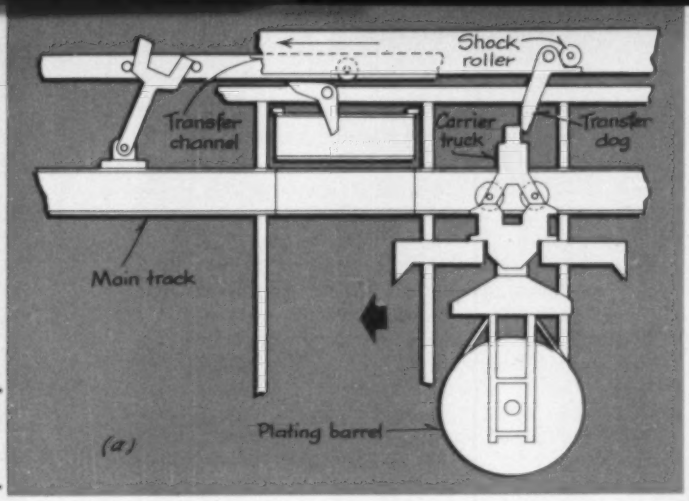
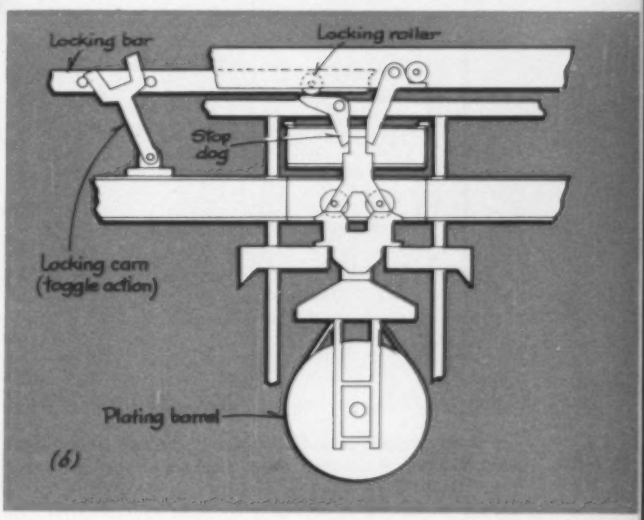


Fig. 2—Diagram illustrates basic details of transfer mechanism for advancing carrier trucks between stations in plating area. Transfer channel is reciprocated by hydraulic cylinder. During leftward stroke, *(a)* transfer dogs on channel engage and push carrier trucks to left along main track. When carrier trucks near stations, *(b)* a locking bar is operated by hydraulic cylinder. This pivots locking cam on a toggle so that locking rollers advance along the tops of stop dogs, preventing dogs from swinging. When transfer dog on transfer channel brings carrier truck into contact with stop dog, truck is held centered at station. Locking bar and roller are retracted to original position, freeing stop dog, during initial portion of return stroke of transfer channel.



dividually controllable work-carrying units combined into automatic systems. Sequencing, routing, and timing of the units should be adaptable to change on demand from the automatic controls.

Two benefits accrue from such an arrangement: 1. Simplicity and economy of producing standardized units. 2. Flexibility to change in operations by simply adding or removing units or by varying the automatic control commands.

A handling system developed by Abbey Process Automation Inc. includes these features in an arrangement that provides maximum flexibility of use for a variety of industrial processes. A barrel plating installation, *Fig.* 1, will illustrate an application of the system.

▶ Loading and Feeding

In operation of the system, empty plating barrels suspended from wheeled carrier trucks are automatically conveyed by monorail to a loading point. When a carrier truck arrives at this point it is automatically stopped and the section of the monorail containing it is separated from the main track and lowered by an elevator. This lowers the plating barrel, previously emptied by an operator, to a convenient height for manual loading by the same operator. Each barrel can hold up to 200 pounds of parts.

After a preset time interval the elevator rises and the monorail section supporting the carrier truck and load is replaced in the main track. A chain-driven hook, traveling horizontally over the monorail, next transfers the carrier truck and load to an accumulating and feeding section. Several trucks and loaded barrels are maintained in this area at all times. An automatic stop and feed control device at the leading end of this section releases a carrier truck and load to the plating process every 3 minutes.

▶ Processing

In the plating area, carrier trucks are advanced from station to station by a hydraulically operated transfer mechanism, *Fig.* 2. Motive force is supplied during the outstroke of a reciprocating transfer channel, *Fig.* 2*a*, that contains transfer dogs at spaced intervals. The transfer dogs engage and push available carrier trucks along the main track between stations. When a carrier truck arrives at a station it is locked in place by a stop dog arrangement, *Fig.* 2*b*.

Each work station in the plating area is equipped with an elevator operated by an individual hydraulic circuit, *Fig.* 3. When signaled by a carrier truck arriving at a station, the elevator at that station will automatically lower the plating barrel into a process tank or an unloading point. The elevators operate independently, and are controlled by timers. Thus, the elevators for the process tanks can be set to provide optimum immersion times for the work. "Drag-through" processing is readily arranged by placing elevators at the ends of long tank sections, and providing supplementary means for moving the carriers in their lowered positions. Overriding pushbuttons are available at each station for maintenance purposes.

Signaling of the elevators is by a lever arrangement which is an integral part of each carrier truck. Depending on the positions of its levers, a carrier

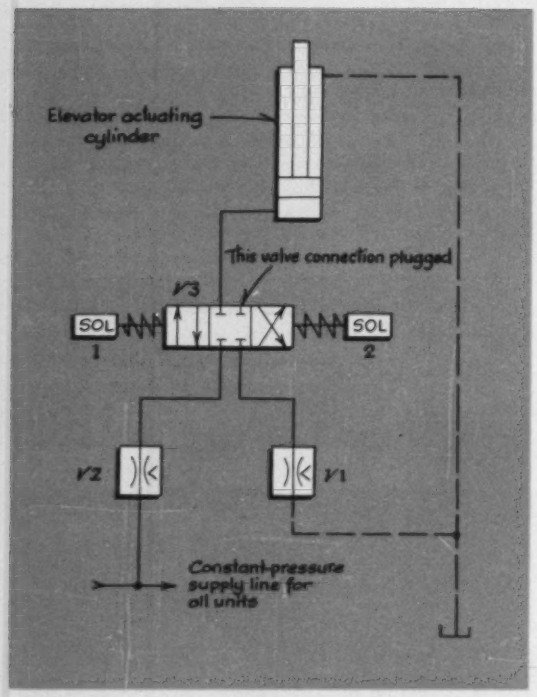


Fig. 3—Hydraulic circuit diagram illustrates components used to control *up* and *down* motion of station elevators. Descent of elevator and load is by gravity force. Speed of descent is retarded by flow control valve V1. Single, constant-pressure hydraulic system provides power to raise all units.

will signal the elevator to lower or will remain in the *up* position at a given station. Setting of the levers can be accomplished by several means. For example, fixed cams can be mounted on the monorail between stations that will operate the levers for a fixed cycle. By providing a combination of fixed and solenoid-retractable cams on the monorail, the cycle can be controlled remotely by pushbutton, punch card, or tape. By positioning an adjustable, variable-position cam on a carrier truck, and programming a set of solenoid-operated cams mounted on the monorail, an operator can select a cycle for that carrier truck that is unique to itself.

Special Actions

An interesting feature of this system is that when an elevator is down, a substitute track segment is placed in the main track in place of the elevator segment. By this means, carrier trucks can pass over, or "leapfrog," carriers in the process tanks, *Fig.* 4. Safety circuits prevent rising of the elevators when carrier trucks are passing over.

Reciprocation of the transfer channel provides "step" transfer of carriers between stations. In this mode of operation a carrier stops at each station and its signaling mechanism commands either an *up* or *down* condition of the elevator.

To improve production, and in certain cases to minimize exposure of loads to air, a "rapid transfer" provision is available, *Fig.* 5. In this arrangement, an auxiliary transfer shuttle operated by a hydraulic motor replaces the transfer channel. The locking bar and stop dogs at each station are retained, but a separate hydraulic cylinder is used to actuate the locking bar. The locking cam is omitted. Operation is as follows: A carrier picked up by the single dog on the auxiliary transfer shuttle is moved rapidly by the shuttle. If an elevator at the next station is down, the carrier will pass this station unimpeded. If it is up, a limit switch at that station will be operated and the carrier will be stopped and lowered. Switches at each station in the rapid transfer section are connected in parallel so that the carrier will always stop and be lowered at the first station having an elevator in the *up* position. In this manner, banks of process tanks containing identical solutions can be fed in minimum time. When a carrier returns to the *up* position in the rapid transfer section it will not signal another

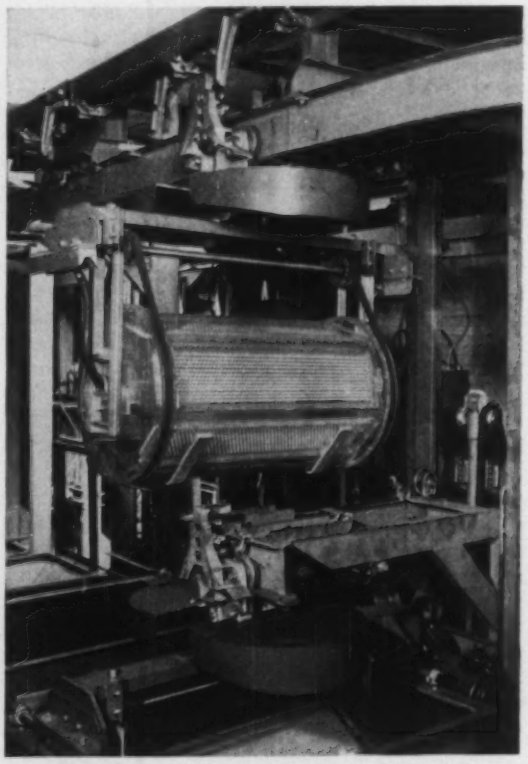


Fig. 4—When an elevator descends to lower a plating barrel into a work area, a substitute track segment is automatically placed in the monorail. This allows passing over, or "leapfrogging," of occupied area by following barrels.

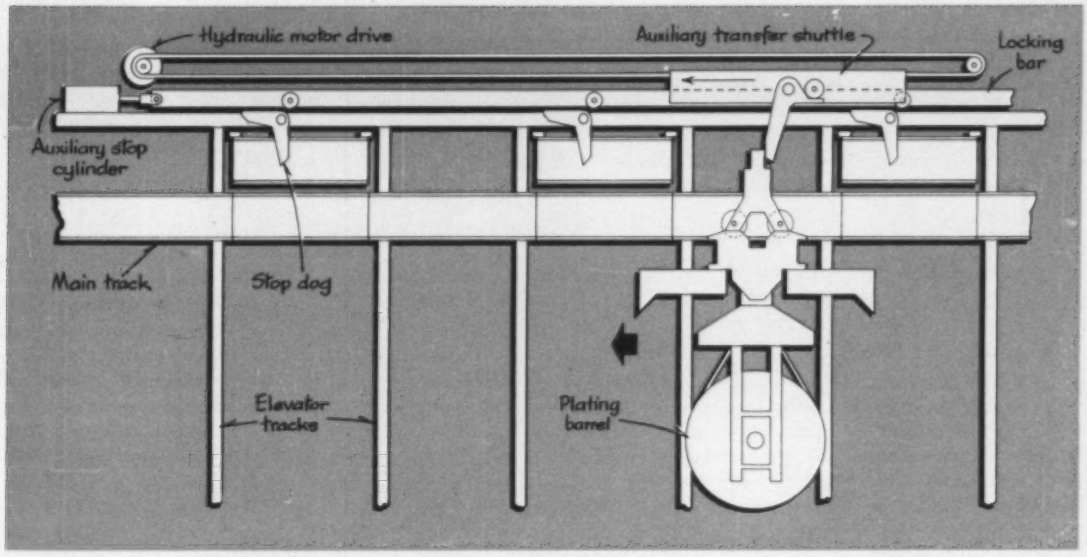


Fig. 5—Auxiliary transfer shuttle is used in portion of conveyor where rapid transfer of carrier trucks and work is desired. Driven by hydraulic motor, transfer shuttle with single dog advances carrier trucks rapidly to left. Limit switches at each station are operable only when an elevator is in its *up* position. If elevator is down, truck will be moved through station on substitute track segment. When carrier truck reaches first available *up* elevator, limit switch at that station will be operated. Resulting electrical signal operates hydraulic valves that stop transfer shuttle drive motor and actuate hydraulic cylinder that locks stop dogs. Carrier truck and work are then lowered by elevator. Rapid transfer feature is useful in reducing exposure time of work in air, increasing production rate, and feeding multiple stations at which process is the same.

elevator in this section because of its withdrawn trip arm. The trip arm is reset before the carrier leaves the section.

▶ Versatile System

In addition to use in tank type processes—electroplating, anodizing, and chemical immersion—the system is adaptable to many manufacturing processes involving molding, assembly, and machining. In plastics molding, for example, "leapfrogging" and rapid transfer actions are particularly useful in that multiple stations at which mold filling, setting, and stripping are performed can be supplied in minimum time as the need for work develops. Thus, stations at which operations require considerable time are merely duplicated, and operations that can proceed faster are not penalized by having to wait.

Because of its standardized, sectional design, the system is adaptable to a variety of factory layouts—usually no rearrangement of equipment is required. It can also be integrated with other handling and overhead storage devices employing both powered and free conveyors.

pneumatic conveyor characteristics

KNOWLEDGE of types of systems available for pneumatic conveying is important in selecting the proper equipment, according to E. D. Swenson, Baker Perkins Inc.

Systems are of two main types—positive and negative pressure. Positive systems operate with air stream pressures higher than atmospheric; negative systems, also called vacuum or velocity, operate at pressures below atmospheric.

Choice of system is influenced by type of material to be handled, conveying rate, distance of transport, horsepower, and need for filtering. High-volume positive pressure systems are commonly used with material-to-air ratios between 15:1 and 30:1. For a given distance and horsepower, positive systems can move materials at twice the conveying rates of negative systems. They also use smaller amounts of air and require less filtering to remove fines.

Low-volume negative pressure systems have smaller material-to-air ratios (between 5:1 and 10:1), but there is no blowback at points where material enters.

MULTIOPERATION PRODUCTION UNIT MACHINES SEVEN SIZES OF CASTINGS

MANUFACTURING flexibility is becoming the keynote in the design, construction, and tooling of new machine tools. To keep pace with expanding product lines, machine tools should be capable of economically producing a family of parts. Michigan Drill Head Co. has recently engineered and built such a production unit to machine seven different sizes of gear reducer housings from rough castings. These housings vary in weight from 85 to 800 pounds and have bore diameters which range in size from 8.750 to 24.750 inches.

The production unit, *Fig.* 1, is composed of two machines—one a 3-station dial type machine and the other an 11-station transfer machine. The rough castings are first machined on the 3-station dial type machine where the bottoms of the feet are milled in one pass at one station, and four mounting holes are drilled in the feet at another station. Two of the holes are combination drilled and reamed to furnish locating holes for the casting on the transfer machine pallet.

The transfer machine is arranged in the form of a rectangle with the eleven working stations split on two sides and transfer conveyors across the ends. The castings are carried through the machine on pallets which are indexed between stations by transfer bars. The pallets are accurately positioned at each station by two shot pins and are locked during machining by hydraulically-actuated clamps. Seven different size fixtures bolt onto the pallets to hold the various size castings. The fixtures are designed to position the center of each size bore on the same horizontal and vertical axes in relation to the various machining heads.

The castings are loaded onto pallets at the first station of the transfer machine. Rough and finish machining of two outer bores, one inner bore, and end flanges is done at the second station. Since operations at the remaining stations are performed in half the time required for boring, castings are machined in two stations on subsequent operations while one part is completed at the second station. Up to twelve bolt holes, four dowel holes, and a drain hole are drilled on the front and rear of the housing at the third station. The four dowel holes are bored at the fourth and fifth stations. The sixth station taps the bolt holes on the front flange and drills vertical filler, breather, and drain holes. At the seventh station these holes are tapped. The eighth station is provided for tool setup and ease of maintenance. At the ninth and tenth stations, horizontal breather, filler, and drain holes are drilled on each side, and then tapped. The final operation occurs at the eleventh station where bolt holes in the rear flange are tapped. The casting is then automatically conveyed past a blow off station where chips are cleaned off the pallet and housing.

Interchangeable drilling and boring heads are used at some of the stations to provide speed and flexibility in changing over from one size part to another. At other stations the same tool spindles are used for all parts and are set up by means of precision spacing gages. All tooling for one size casting is color coded for quick identification and arranged around the transfer machine in tool racks.

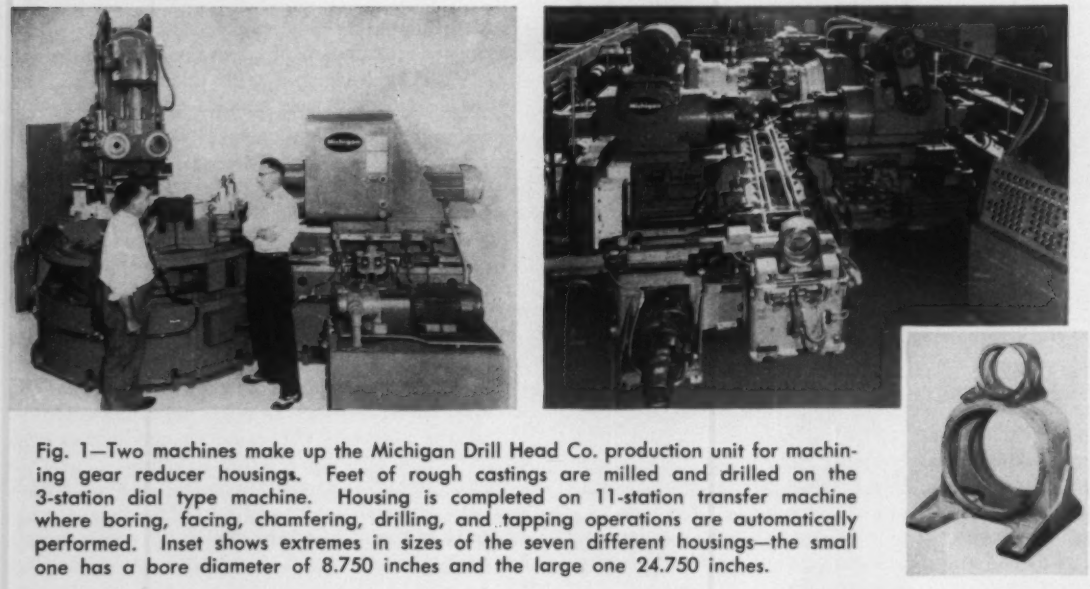


Fig. 1—Two machines make up the Michigan Drill Head Co. production unit for machining gear reducer housings. Feet of rough castings are milled and drilled on the 3-station dial type machine. Housing is completed on 11-station transfer machine where boring, facing, chamfering, drilling, and tapping operations are automatically performed. Inset shows extremes in sizes of the seven different housings—the small one has a bore diameter of 8.750 inches and the large one 24.750 inches.

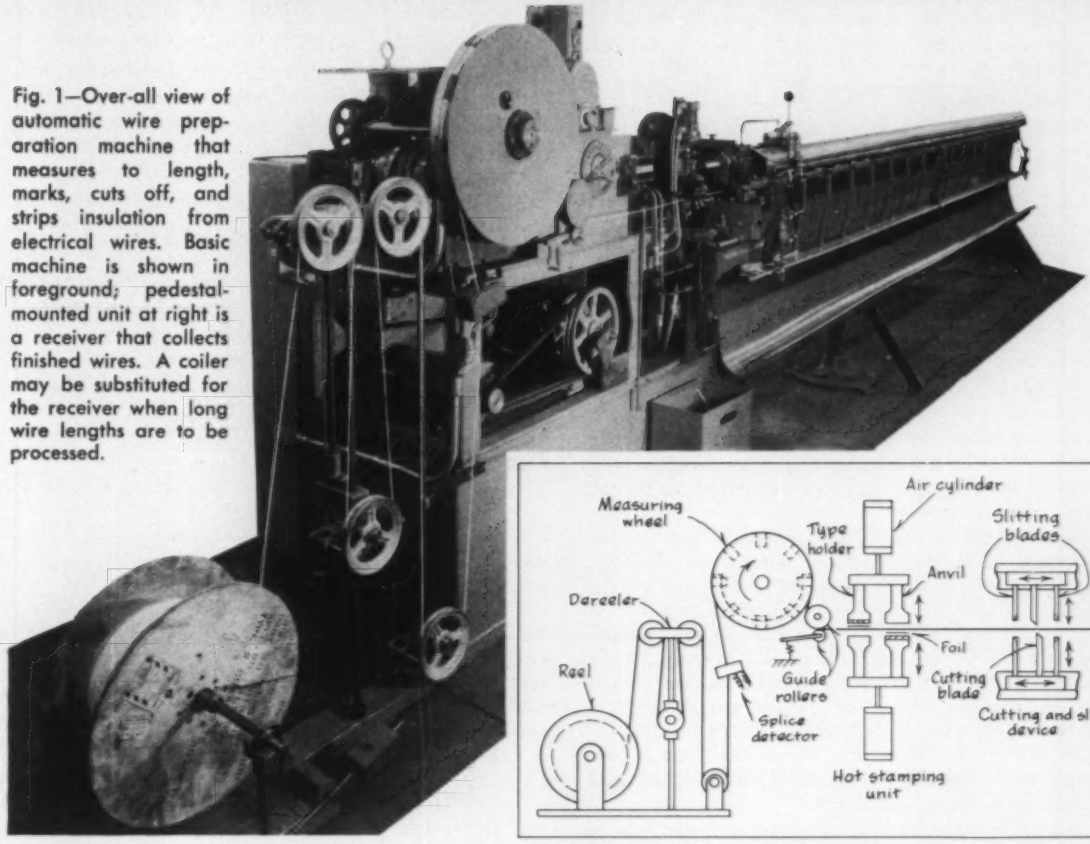


Fig. 1—Over-all view of automatic wire preparation machine that measures to length, marks, cuts off, and strips insulation from electrical wires. Basic machine is shown in foreground; pedestal-mounted unit at right is a receiver that collects finished wires. A coiler may be substituted for the receiver when long wire lengths are to be processed.

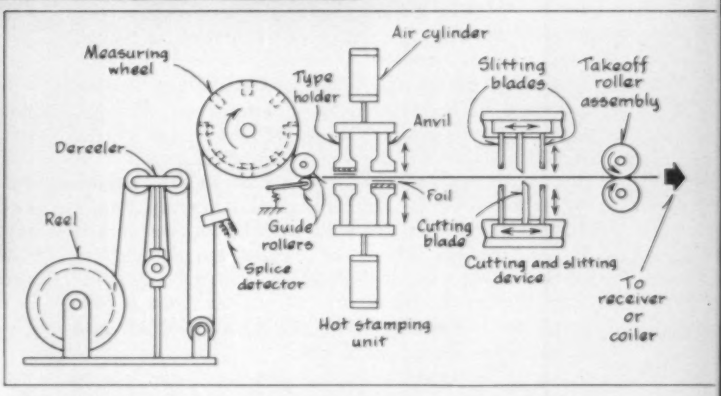


Fig. 2—Sketch illustrates basic elements of setup. Accuracy in measuring wire to be cut is obtained by gripping wire in spring-loaded clamps on measuring wheel. Cam segment opens clamps at points where wire enters and leaves wheel. Splice detector senses presence of factory splices covered by insulation.

MACHINE PREPARES WIRES

FOR ELECTRICAL ASSEMBLIES

INCREASE in quantity and complexity of electrical and electronic apparatus used in modern military aircraft and missiles has caused a corresponding need for more lengths of prepared wire. As a result, manual methods are no longer practical for the operations of measuring, marking, cutting off, and stripping individual lengths of wire. To meet increased demands for prepared wire used in these applications, Artos Engineering Co. has developed an automatic machine, *Fig.* 1. The unit employs Warner Electric Brake & Clutch Co. products to control the various machine actions.

In operation, insulated wire in sizes from 10 to 24 gage is taken from a reel and passed through various operating sections of the machine, *Fig.* 2. The first section, a dereeling device, includes a series of pulleys, one of which is free to rise and fall on a vertical rod. Function is to control wire tension and absorb fluctuations in feed rates. A splice detector at the exit of this section senses the presence of splices in the wire and provides an electrical signal when they appear.

Wire coming through the splice detector is next passed around a portion of the periphery of a measuring wheel. This element is essentially a large pulley that contains spring-loaded wire clamps spaced

MACHINE PREPARES WIRES

around its circumference. A circular cam that conforms to the lower portion of the measuring wheel holds the clamps in an open position in this area so that the wire can be introduced to and removed from the wheel. The clamps close on the wire passing around the upper portion of the measuring wheel, thus providing a means of withdrawing the wire from the reel without slippage between wire and wheel.

Desired cutting length for a given run is manually set on a predetermining-type counter. This device governs the angle of rotation of the measuring wheel, and hence the amount of wire fed for each machine cycle. The initial and final portions of the feeding cycle are at a relatively slow wire speed of 6 ips, while a faster rate of 30 ips is maintained in the middle portion of the cycle. Speed changeover is effected through two electric clutches in the measuring wheel drive system. These clutches alternately engage the proper gears in a train to provide the desired speeds. When the correct length of wire has been fed, an electric brake is actuated automatically to stop the measuring wheel. Accuracy is plus or minus 1/16-inch for lengths to 100 inches, and 0.2 per cent for longer lengths.

From the measuring wheel, the wire passes through a guide pulley arrangement and enters a marking section. Here it is stamped top and bottom by a pneumatically operated stamping device operating on a constant cycle. A hot-stamping process is used that employs heated type and marking foil. The foil is indexed to provide new surfaces each time the device is operated. Anvils opposite the type holders support the wire during the marking process. Markings are made at intervals throughout the length of the wire as it passes through this section of the machine.

As the wire moves from the stamping section it travels between a set of cutting and stripping blades and is picked up by a pair of take-off rollers. The take-off rollers feed the wire to a final section of the machine, which may be a receiver or a coiler. Choice depends upon the cutting lengths involved, a coiler being necessary to handle long lengths.

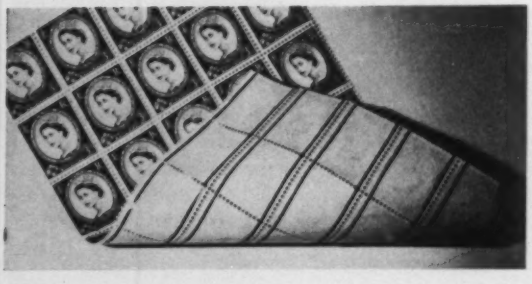
When the predetermined length of wire has been delivered by the measuring wheel, and the latter element stops, the cutting and stripping device is closed on the wire. Cutting blades then sever the wire, and stripping blades on either side of the cutting blades grip the insulation a preset distance (1/8 to 5/8 inch) along the wire from the cutting point. At this time the take-off rollers are still engaging the wire, so that the leading wire length continues to be fed into the receiver or coiler. This wire is thus automatically stripped at its trailing end in the process of being pulled out of the cutting and stripping section by the take-off rollers.

Stripping of the next wire at its leading end is accomplished by motion of the cutting and stripping section on a slide toward the exit end of the machine. At the end of this motion the cutting and stripping blades are separated and the take-off rollers are disengaged from the wire. An electric clutch-brake in the transmission for the cutting and stripping section controls these actions. If a receiver is used, the leading wire length is dropped into a collecting trough at this time. Upon completion of the cycle, operations are repeated automatically until the desired number of wires is produced.

conductive ink process sorts mail

PARALLEL, graphited ink lines printed on the backs of postage stamps are a key feature of an automatic mail sorting system being tested by the Government Post Office of Great Britain. If successful, the system may find additional use in speeding and improving accuracy in business accounting, computing, and sorting procedures.

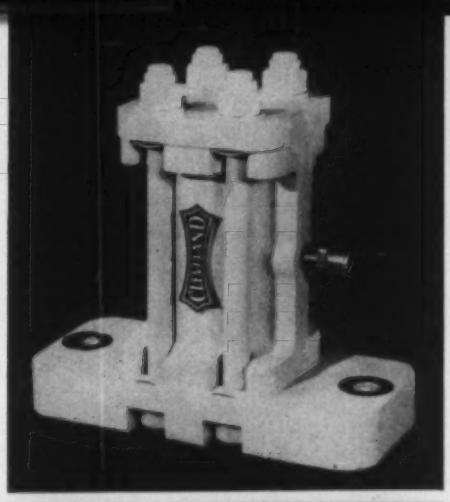
The printed lines, which are electrically conductive, are detected electronically in a machine that automatically orients letters with their faces up and their stamps in the upper righthand corners. Stamps that have markings are distinguished from plain stamps, thus enabling separation of mails of different classes.



A British Government Post Office Research Team originated the idea; Harrison & Sons Ltd., stamp printers, developed printing techniques; and Acheson Colloids Ltd., a subsidiary of Acheson Industries Inc., Port Huron, Mich., developed and produced the graphited, conducting ink.

Biggest problem in developing the special ink was to overcome limitations of the stamp printing process. Photogravure printing depends on the transfer of small areas of ink to the paper from etched "dots" on a rotary cylinder. But, to be conductive, the ink lines must be continuous. This meant that an ink was needed which had the ability to spread over the paper so as to link adjacent dots. At the same time, excessive blurring could not be tolerated.

Other qualities required of the ink are nontoxicity, resistance to moisture absorption, and quick drying.



Courtesy, Cleveland Vibrator Co.

Fig. 1—These air-operated units are typical of the piston-type pneumatic-hydraulic vibratory devices. The forces produced by starting and stopping a piston inside such a unit are transmitted through the body to any object on which the vibrator is mounted.

TYPES OF VIBRATORY DEVICES

- PNEUMATIC-HYDRAULIC
- ELECTROMECHANICAL
- ELECTROMAGNETIC

- FEEDING AND CONVEYING
- AGITATING
- COMBINED FUNCTIONS

Vibration can be a valuable ally in the performance of industrial functions. Recognizing application possibilities and selecting suitable vibratory equipment for the job can lead to greatly improved operations. This discussion of basic types of vibratory devices and areas of application provides information useful in all types of industry.

By **LESTER R. MOSKOWITZ,** Director, L. R. Moskowitz & Associates, Erie, Pa.

VIBRATION is a phenomenon found in most industrial equipment. Oftentimes it is unintentionally generated and not desired. However, there are many places in which intentionally produced vibratory motions serve to speed up an operation, ensure a more uniform action, or perform a function that may be difficult to accomplish by any other means. Vibratory equipment which deliberately generates and uses vibration has attained widespread use in recent years in automatic industrial processes. In spite of this broad usage, the potentialities of such equipment applications are far from being fully realized. This series of articles will present information to help increase general understanding of how this equipment works, its capabilities, and its limitations.

The Basic Types

Industrial vibratory equipment may be classified by operating principles and by functions. Classification by principles of operation is based on the means of providing operating energy. The three

general operating types are: 1. Pneumatic-hydraulic. 2. Electromechanical. 3. Electromagnetic. Common industrial equipment can be further categorized into subclasses of these three general types, TABLE 1.

By function performed, vibratory equipment can be divided into three categories: 1. Feeding or conveying. 2. Agitating. 3. Combinations of feeding, conveying, agitating, and/or other processing functions. Vibratory devices used for feeding or conveying include units that move objects linearly in a generally horizontal plane and also those that move material helically or spirally in a vertical plane. Feeders and conveyors may also be classified by the type of material handled. The two major classes are bulk material handling units and parts handling units. Both linear and helical units can be applied to handling either type of material, but linear units have found the most widespread use in handling bulk materials. Helical units, particularly those of small size, are used most widely to handle small parts.

Pneumatic-hydraulic. Vibratory equipment powered by pneumatic or hydraulic energy sources may be of a piston construction or a rotating-ball construction. A piston unit, *Fig.* 1, may have an internal construction similar to that shown in *Fig.* 2. A fluid medium such as air, oil, or water is used to move a piston alternately back and forth. The reactions necessary to accelerate the piston and/or the impact forces exerted by the piston at the ends of its stroke are used to impart reciprocating forces to any object to which the device is attached.

A typical commercially-available rotating-ball type unit, *Fig.* 3, may be constructed as shown in *Fig.* 4. Here a heavy ball is propelled around a circular path by the fluid medium, usually air. Forces exerted by the ball upon its housing provide a vibratory effect.

The primary means of controlling pneumatic-hydraulic units is to regulate the pressure of the fluid used to actuate the device. By varying the input pressure, the work output of the unit can be readily changed. Control by means of pressure is usually satisfactory, except that, in most units, pressure changes affect both the forces developed and the frequency of vibration. A change in both of these factors can prove to be a disadvantage since the action of the vibrator may be adversely affected by other equipment operating on the same fluid supply system.

TABLE 1
Types of Vibratory Equipment Classed by Principle of Operation

Pneumatic-hydraulic	
	Piston
	Rotating-ball
Electromechanical	
	Eccentric mass
	Direct linkage
Electromagnetic	
	Pulsating dc
	Combined ac & permanent magnet
	Direct ac

As indicated in TABLE 2, the primary advantage of pneumatic-hydraulic units is their low initial cost. Initial cost of this type of unit is in general lower, size for size, than for any other type. This is particularly the case where just the basic vibratory unit is required, as in agitating applications. The cost of providing the source of fluid power, while sometimes overlooked, is nevertheless very important. Also, the cost of auxiliary equipment such as pressure regulators, oilers, filters ,etc., add to the total outlay for these units.

Pneumatic-hydraulic units are the most acceptable for operation in explosive or dust-filled atmospheres, since they do not contain electrical elements. They also may be operated in areas with considerably higher ambient temperature than other types. The limiting factors in their application to high temperature areas are the clearances between moving parts, the materials used, end the fluid lines supplying the unit.

Although these units can be operated in dust-filled atmospheres, they are subject to contamina-

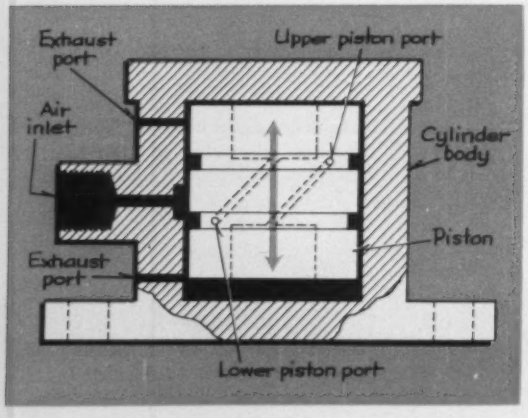
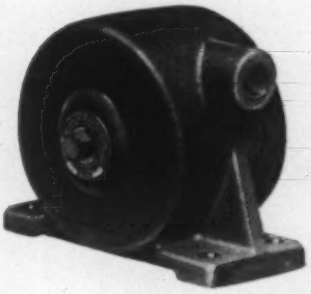


Fig. 2—Cutaway sketch of piston-type vibrator shows the moving element, a piston, enclosed in its cylinder body. Air entering the piston groove exposed to the air inlet applies pressure to the upper end of the piston, impelling it downward. Air is exhausted through ports as piston moves. Similar action is repeated when piston reaches the bottom of its stroke. Piston therefore reciprocates continually while air is supplied.

TABLE 2

Features of Pneumatic-Hydraulic Vibrators

Advantages	Disadvantages
1. Lower initial cost (unit alone).	1. Cost of providing source of fluid power.
2. Smaller in size than equivalent units of other types.	2. High maintenance, especially on piston-type units.
3. May be used more readily in hazardous atmospheres.	3. Noisier than other equivalent types.
4. May be operated in areas with high ambient temperatures.	4. Subject to contamination and subsequent malfunctioning.
5. Insensitive to electrical system changes.	5. Air units require accessory equipment.
6. Work output readily controlled by pressure.	6. Frequency of vibration and work output may be affected by other equipment on same supply system.
	7. Apply intermittent loads to supply system.
	8. Maximum size of units limited by capacity of supply system.



Courtesy, Martin Engineering Co.

Fig. 3—A second major type of pneumatic-hydraulic vibrator is represented by this air-operated rotating-ball unit. Air supplied to the unit rolls a steel ball around a circular raceway. Since the rotation of the ball within the race represents an unbalanced rotating mass, oscillating forces are generated by the unit.

tion and subsequent malfunctioning. In general, the maintenance on these units is somewhat higher than on some other types because of cleaning required and wear in rapidly moving parts.

Since these fluid units are only indirectly connected with an electrical system, variations in the electrical supply system have little or no effect on their performance.

Maximum size of such units is limited largely by the economics of providing a sufficiently large fluid source to operate the device. The largest available air units operate at approximately 120 psi and require about 30 cfm. Units of the hydraulic type operating at 90 psi and 500 gpm are not uncommon.

Noise level of pneumatic-hydraulic units varies widely with the specific design. The piston types are generally noisier than the rotating types. With regard to noise, rotating-ball units compare very favorably with electromechanical and electromagnetic units.

Electromechanical. Many variations of electromechanical types of vibratory equipment are possible. All of these types rely upon the action of either an eccentrically-mounted rotating mass, as in *Fig.* 5 and 6, or on a direct linkage, as shown in *Fig.* 7 and 8.

With such units, the element to be vibrated is resiliently mounted on springs or rubber pads. The springs or pads are frequently selected so that their stiffness is such as to provide a mechanically tuned or resonant system when considered with the mass of the object to be vibrated. Such equipment is seldom designed so that the natural frequency of the system coincides with the drive frequency (the condition known as resonance) because of the difficulties of control over such resonant systems. In some cases, however, frictional damping is intro-

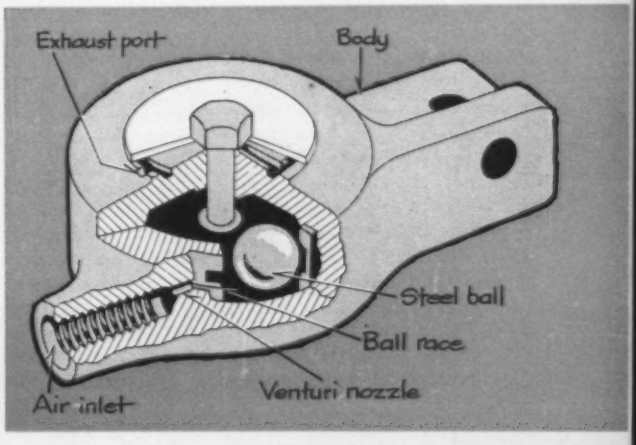
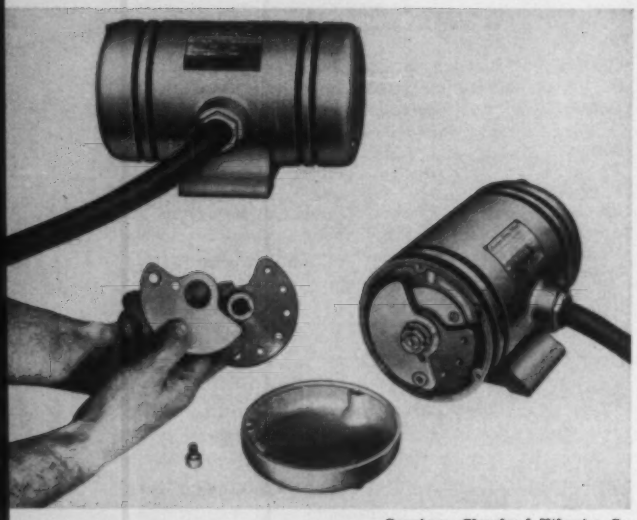


Fig. 4—Partial cutaway view of rotating-ball vibrator indicates its means of operation. Velocity of the air entering the inlet is increased in a nozzle, and a high-speed jet is produced. The forces exerted by the moving ball are transmitted from the vibrator body to the member supporting it.



Courtesy, Cleveland Vibrator Co.

Fig. 5—Typical electromechanical type of vibrator is exemplified by these rotating-mass units. Design shown allows adjustment of the unbalanced mass represented by the two partial-disc elements.

duced to permit operation very close to or at resonance.

Both the eccentric mass and the direct linkage types are usually operated by a conventional electric induction motor. The use of such motors simplifies the operation of these units in hazardous locations. Since properly selected electric motors are relatively insensitive to power variations, the effect of such variations on electromechanical vibratory units is negligible. These units are the only electrically operated type of vibratory equipment that can be used readily on all electric power systems.

One of the outstanding characteristics of most electromechanical types, TABLE 3, is their quiet operation. The most widely used units are of the simple unbalanced mass type, and the only sound produced is that generated in the bearings.

Electromechanical vibratory units are usually bulky compared to pneumatic-hydraulic and electromagnetic types of equivalent capacity. Size may pose problems when electromechanical units are selected for application to existing machines or where space and weight are a major consideration.

Maintenance requirements of electromechanical units are usually higher than for electromagnetic types; but they are usually lower than for pneumatic-hydraulic types, particularly the piston-type air units. Maintenance required is largely the result of the eccentric loading applied to the bearings by the off-center mass that produces the vibratory forces.

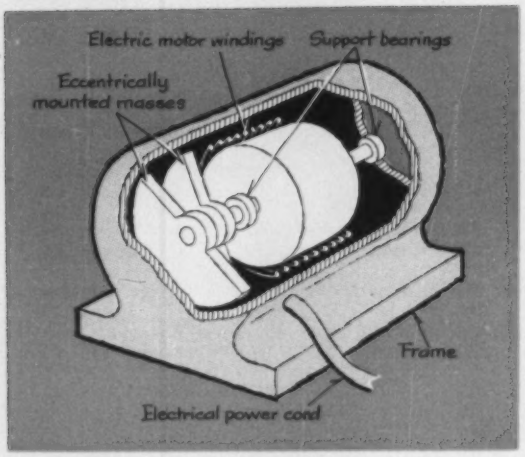
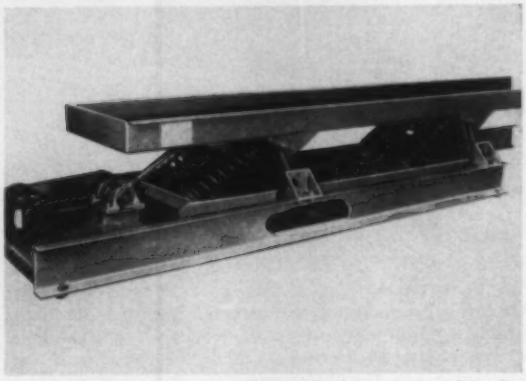


Fig. 6—In electromechanical vibrators of the rotating-mass type, conventional induction motor principle is used to drive the unit from an ac power source. Forces developed by the unbalanced rotating mass produce the desired vibratory action.



Courtesy, Stephens-Adamson Mfg. Co.

Fig. 7—Second major type of electromechanical type vibrator is represented by the direct linkage unit that drives this linear conveyor.

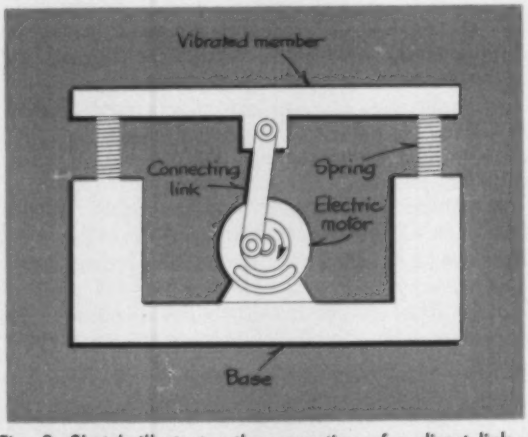
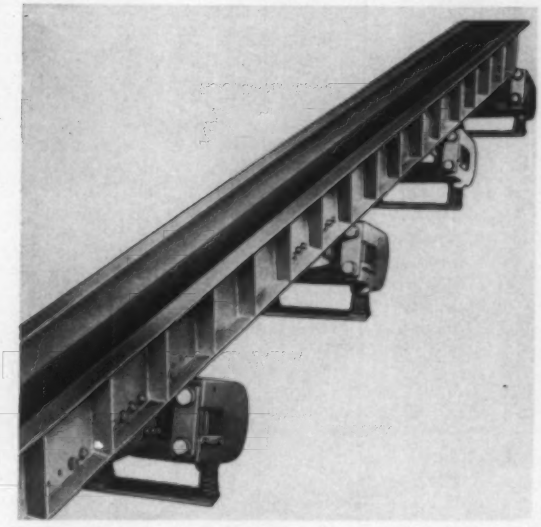


Fig. 8—Sketch illustrates the operation of a direct linkage vibrator. Vibrating forces are transmitted to the object to be vibrated by means of a direct mechanical linkage driven by an eccentric pin or cam element. Object to be vibrated is usually resiliently mounted.

The most serious disadvantage of electromechanical types is the difficulty in adjusting either the amplitude or the frequency of the vibration. In units with ac motors, both amplitude and frequency are difficult to adjust. In units with dc motors, the frequency can be controlled readily by changing the speed of the motor. In ac units, variable speed motors, gear changers, pulleys, or similar means must be used to change frequency. In both types, change of amplitude is usually accomplished by fairly complex mechanical systems that are not readily adaptable for remote control.



Courtesy, Syntron Co.

Fig. 9—Application of the electromagnetic type of vibrator is demonstrated by this linear conveyor driven by pulsating dc vibrators. Pulsating dc power is obtained by applying ac power to a half-wave rectifier.

Electromechanical units are commonly used in cases where very large vibratory forces are required, such as in railroad coal car shakers. There is virtually no limit to the size that can be produced. In the case of smaller units, the cost of the electromechanical type is considerably higher than that of the pneumatic-hydraulic or electromagnetic types. In large units, their costs compare favorably.

Electromagnetic. Three basic types of electromagnetically operated units are commonly available. In the pulsating dc type, *Fig.* 9 and 10, a half-wave rectifier (usually of the selenium type) rectifies alternating current and provides pulses of dc power to an electromagnet. It is used to attract and release an armature. Springs are used to restore the armature to the original position during the release portion of the cycle. By this means, an oscillating force is developed whose frequency is equal to that of the electrical power source.

In the second type of electromagnetic unit, the combined ac and permanent magnet type, *Fig.* 11 and 12, an ac electromagnet is used to alternately attract and repel an armature in which the permanent magnet is incorporated. Springs are normally used to support the armature element. Frequency of operation is always equal to that of the power source.

Direct ac units, the third electromagnetic type, have a structure similar to that used for the pulsating dc type. The alternating current is applied

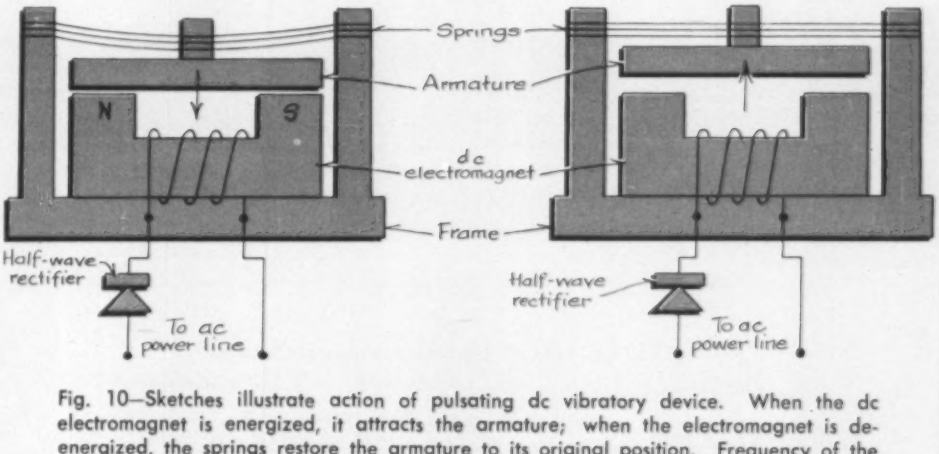


Fig. 10—Sketches illustrate action of pulsating dc vibratory device. When the dc electromagnet is energized, it attracts the armature; when the electromagnet is de-energized, the springs restore the armature to its original position. Frequency of the vibrating force is determined by frequency of ac power from which the pulsating dc power is obtained by rectification. In the direct ac type of vibrator, the ac power is applied directly to a similar structure and the armature is attracted and released at a frequency twice that of the power supply.

directly to the unit, and the armature is alternately attracted and released at double the power line frequency.

One of the primary advantages of electromagnetic types, TABLE 4, is the low cost for a complete operating system. Where control means are required, the controls are usually provided with the unit; no auxiliary equipment is needed. The lower cost of electromagnetic units is largely the result of their inherent simplicity.

Controls for electromagnetic vibratory equipment are simple voltage-varying devices since the magnitude of vibration produced by such units is proportional to the input voltage. The range, selectivity, and increments of control are dependent on the steps from zero to full line voltage that can be applied to the electrical drive. Most units use wirewound rheostats or variable autotransformers. Very close control of electromagnetic vibrators is practicable. The units are readily adaptable to use with automatic power line voltage regulators and electronic feedback systems. The voltage sensitivity of electromagnetic vibrators may be a problem in some cases where wide fluctuations in power line voltages occur, unless such fluctuations are corrected by auxiliary equipment. Electromagnetic vibratory devices always operate at a frequency equal or double that of the power line frequency. They can be used only on ac systems, and the operating frequency of the device cannot easily be altered.

Electromagnetic vibratory units are generally smaller in size than electromechanical types of equivalent capacity, but they are usually larger than equivalent air types. There is no limit to the maximum size of electromagnetic units that can be designed, since weights, springs, and power supply systems impose no limitations.

Since a high degree of enclosure of all electrical components is required, electromagnetic units are difficult to design for use in hazardous atmospheres. Also, the connection to the power system is difficult to make in accordance with safety standards. Rigid conduit cannot be used, since the vibratory unit, or the object to which it is attached, is actu-

TABLE 4

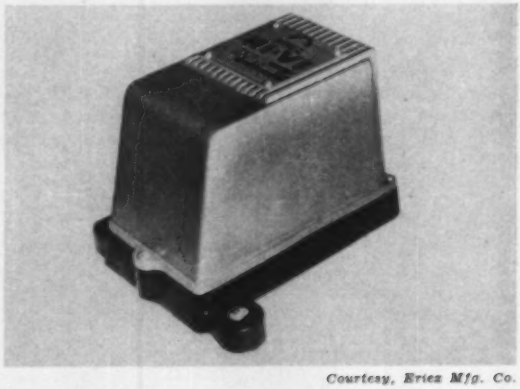
Features of Electromagnetic Vibrators

Advantages

1. Low cost for complete system.
2. Simplicity of control.
3. Smaller in size than electromechanical units.
4. Quieter than most pneumatic-hydraulic units.
5. Low maintenance.
6. No special power sources required.
7. Virtually no limit as to maximum size of units.
8. Highest efficiency of all types.

Disadvantages

1. Difficult to adapt for use in hazardous locations.
2. Limited as to operation in high temperature areas without special provisions for cooling.
3. Sensitive to power line variations.
4. Fixed frequency of operation.
5. Sensitive to personnel tampering.
6. Can be used on ac power systems only.
7. Require specialized know-how to apply and service properly.



Courtesy, Eriez Mfg. Co.

Fig. 11—Example of combined ac and permanent magnet type of electromagnetic vibratory unit requires no special power source. Armature of this unit is reciprocated at power line frequency.

TABLE 3 Features of Electromechanical Vibrators

Advantages

1. Quiet operation.
2. Virtually no limit to size of units.
3. Readily adaptable to contaminated or hazardous locations.
4. No special accessory equipment required.
5. Use conventional electric motor drives.
6. Low sensitivity to electrical system changes.

Disadvantages

1. Work output control complicated.
2. Largest in size for given rating.
3. High maintenance cost on bearings.
4. Highest initial cost of all types.

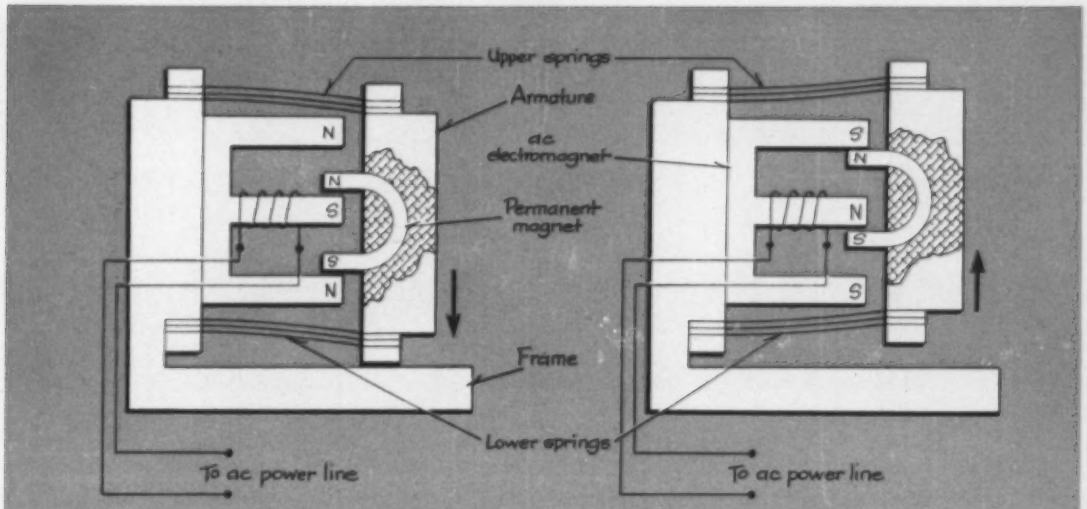


Fig. 12—In a combined ac and permanent magnet unit as sketched here, a permanent magnet is attached to the spring-mounted armature. Legs of the permanent magnet lie between legs of an E-shaped electromagnet. When ac power is applied to the electromagnet, the armature oscillates up and down. Forces generated are transmitted through springs and frame to element on which the vibrator is mounted.

ally in motion. While the amplitude is small, the frequency is high—usually 2500 to 7200 vibrations per minute—and even flexible types of conduit are unsatisfactory.

In small size units, electromagnetic vibrators are largely maintenance free. In larger sizes, particularly of the impact type, periodic replacement of springs or impact elements is required. The most common causes of spring failures are corrosion and "packing" by foreign materials. If properly designed, the electrical elements seldom require replacement.

The electrical coils are usually the limiting factor on the maximum ambient temperatures at which these units can be operated. By using Class H wire insulation, fairly high ambients are allowable, but electromagnetic units are far more limited in this respect than pneumatic-hydraulic units.

Vibratory devices of the electromagnetic type are usually quieter in operation than comparable air types. This is largely due to provisions for shielding of the units and to the use of rubber cushioning means. These vibratory devices are usually available in three types: 1. Noiseless. 2. Seminoiseless. 3. Impact. The so-called noiseless units are generally of an inertial type with no actual hammering action. In the seminoiseless and impact types, various measures for noise reduction are incorporated, but both types rely on direct hammering action. In very large sizes, only impact types are usually available.

Tampering by unskilled personnel may present serious problems with electromagnetic types. Since these units all operate on a mechanical resonance principle, factors such as spacing between magnetic elements and tightness of spring clamps are critical. Unskilled disassembly or adjustment of such a unit frequently results in malfunctioning.

Uses of vibratory devices for the three basic types of functional applications (feeding or conveying; agitating; combinations of feeding, conveying, agitating, and/or other functions) will be presented in succeeding installments.

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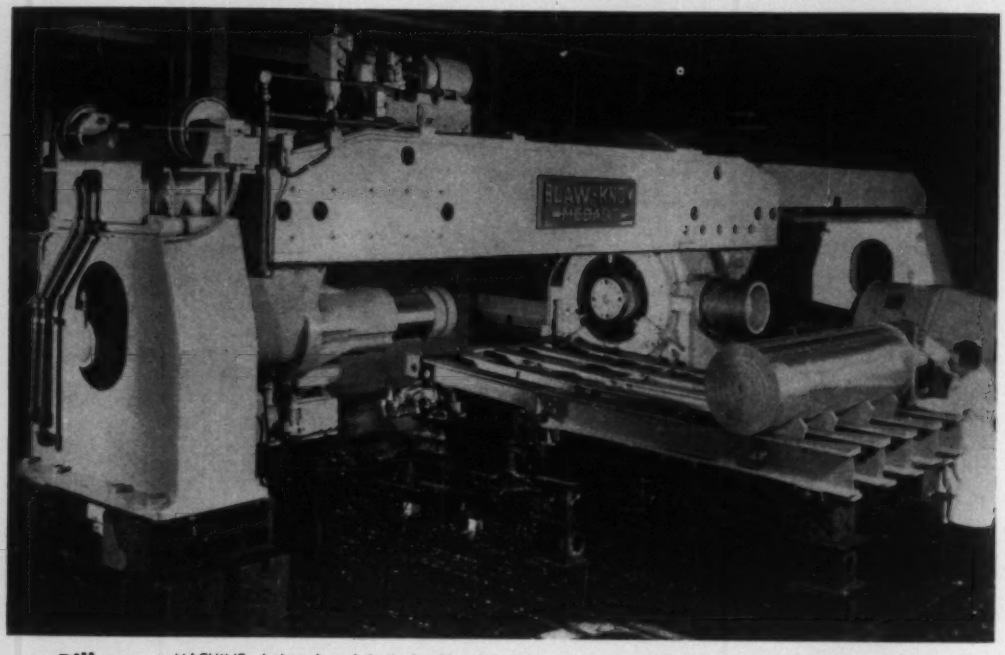
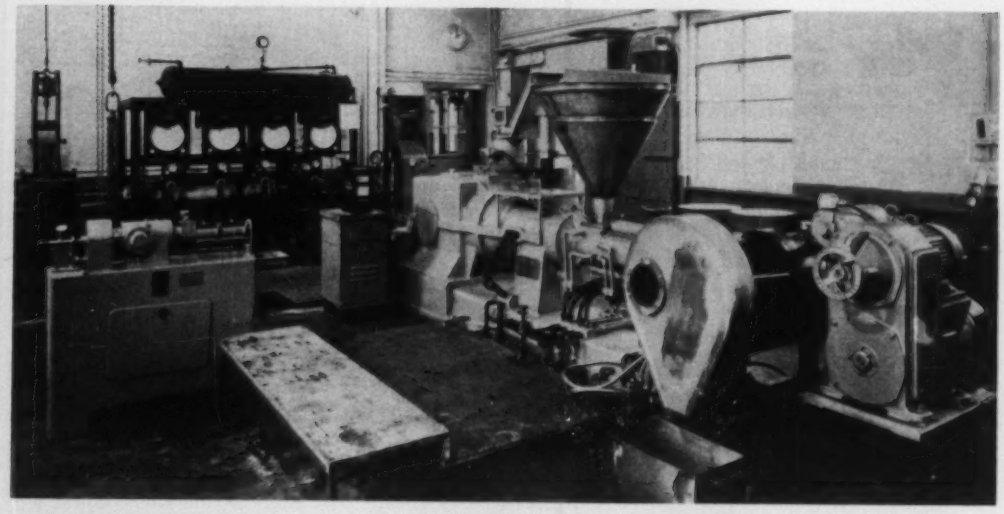


Billet Peeler

MACHINE designed and built by Blaw-Knox Co. skins or peels cast or rolled billets up to 33 inches in diameter prior to extruding the billets in an extrusion press. The Blaw-Knox Medart peelers are designed to operate at production speeds up to 40 fpm and to take as much as 1-inch depth of cut. Peeling is accomplished by tools in a multitool rotating cutterhead through which the billet is fed. Peeling a billet before extrusion provides greater yield and longer die life.



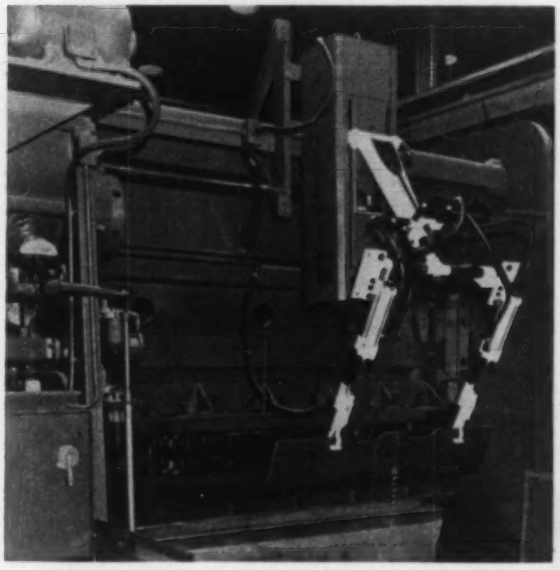
Experimental Mixer

ENGINEERING information to solve users' problems of mixing plastics and similar materials is being provided by new experimental continuous KO-Kneader mixer installation designed and built by Baker Perkins. The unit is installed in the research and development laboratories of the company's Chemical Machinery Div. The type of continuous mixing system employed has replaced batch mixers for such applications as premixing polyester resins for automobile heater housings and mixing carbon for electrodes used in aluminum reduction furnaces. Major advantages of the continuous mixing system include higher quality, increased production, and reduced floor space required by the equipment.

in action

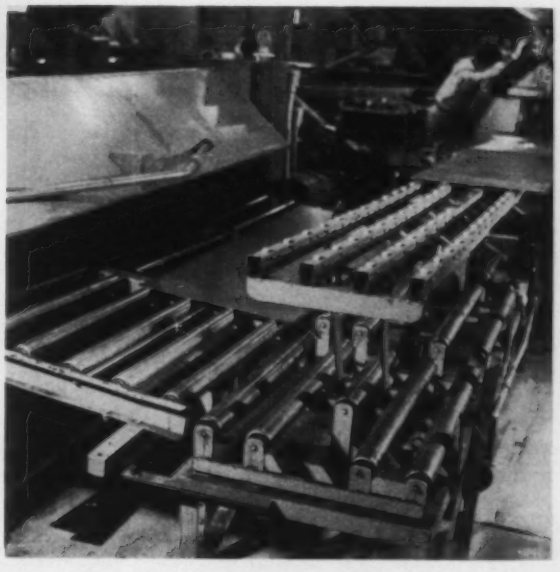
Data Processing

ELECTRONIC data processing system installed by Michigan Blue Cross - Blue Shield keeps track of hospital and medical records of some 1.6 million Michigan subscribers. Approximately 25,000 daily record changes in transactions are handled by the system, which was designed and built by the Datamatic Div. of Minneapolis-Honeywell Regulator Co. Records are stored on 20 reels of 3-inch wide magnetic tape. Information can be added to or abstracted from magnetic tape at a rate of 60,000 digits per second. The high-speed printer associated with the system can print out data at the rate of 900 lines per minute.



Press Brake Unloader

UNIQUE production application of a press unloader has been made by the Cincinnati Shaper Co. for a press brake in use at a Westinghouse Electric Co. plant. End frames for medium duty transformer tanks are produced at the plant. Normally, when a long and unwieldy part such as this is produced, standard practice is to unload the press brake by hand. The installation of a Sahlin Engineering Co. Inc. Iron Hand on this press brake has enabled an increase in production in a traditionally slow type of operation, and provided greater safety for the press brake operator.



Gravity Conveyor System

PRODUCTION paced transfer conveyor has reduced the cost of moving material from a shear (left) to a press brake (rear) by 75 per cent at the TV-Radio Div. of Westinghouse Electric Corp. Sheared sheet is conveyed by a gravity roller conveyor to a position above a transfer conveyor of channel-mounted wheel rollers. When the sheet hits stop bars, a limit switch is tripped which actuates an air cylinder that elevates the transfer conveyor and sheet to an inclined position as illustrated. The sheet is then transferred by gravity to a loading point adjacent to the press brake. Interlocks provide that a sheet from the shear will be held until the transfer conveyor is in a down position, and that the transfer conveyor will remain in the down position until the loading point at the press brake is empty.

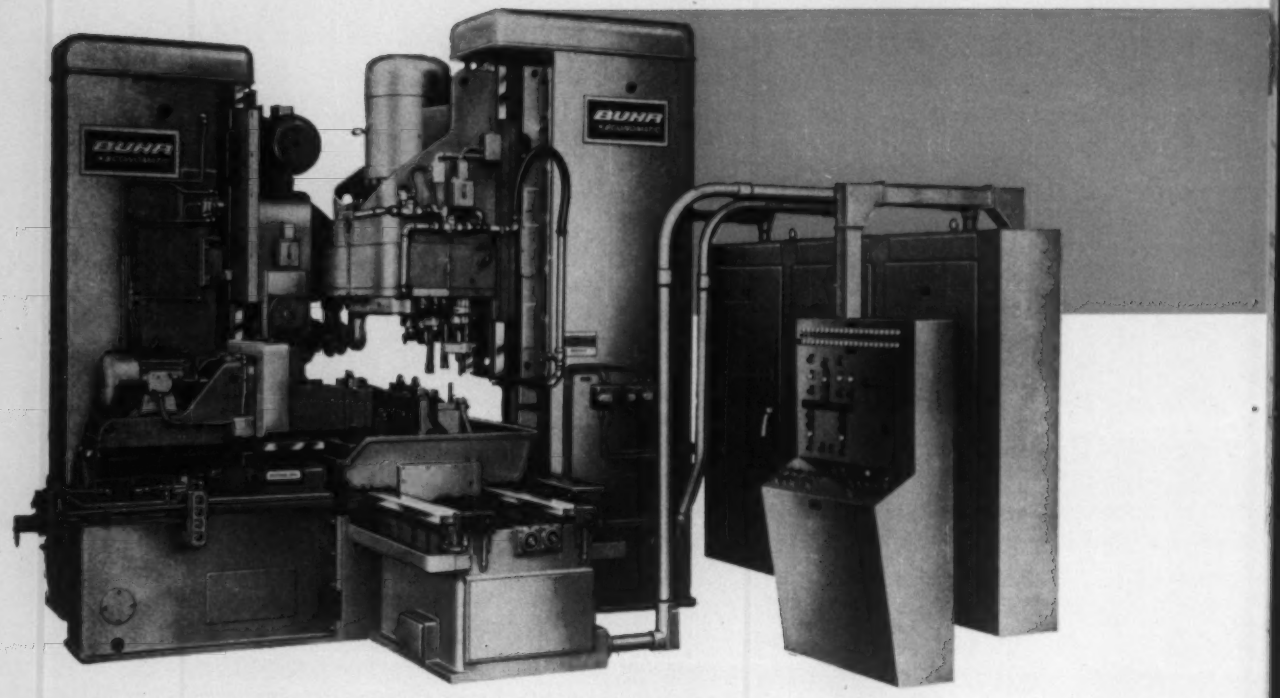


Fig. 1—Transfer machine employs a traveling pallet that carries workpiece on a fixture through a battery of machining heads. In automatic cycle, pallet stops only at stations where machining is to be done, then returns to operator's position for unloading. Three building-block type machining heads have a total of 21 tool spindles. Machine can be programmed to route pallet to any or all of 20 stations.

MACHINING OPERATIONS SELECTED BY

ELECTROMECHANICAL POSITIONING SYSTEM

By **MICHAEL ZAJAC**, Vice President, Engineering, Buhr Machine Tool Co., Ann Arbor, Mich.

JUSTIFYING an investment in automation equipment is usually more difficult for the small-lot producer than for the manufacturer whose volume of like products is great. Continuing efforts on the part of machine tool builders are aimed at alleviating this condition by making equipment available that is specially designed to suit the needs of small-lot producers.

Several approaches are being taken by machine tool builders, among which are: 1. Providing flexibility of operation of their equipment, wherein several broadly similar parts may be run on a single machine with only minor tooling and setup changes. 2. Utilizing building-block construction that combines the advantages of standardization, adaptability to change, and ease of fabrication, assembly, and maintenance. 3. Using simplified, reliable programming controls.

A multioperation machine, *Fig.* 1, developed by Buhr Machine Tool Co. for a manufacturer of earth-moving equipment, illustrates use of all three of these techniques. A number of carrier-roller supports, *Fig.* 2, can be machined in the unit. The parts are used in the

Machine tool builders are actively endeavoring to provide automatic production equipment to suit the special needs of small-lot producers. Flexibility of operation and adaptability to handle a variety of part types are essential features of such machines. Progress of one machine tool builder in developing a machine with the requisite versatility is recorded.

track mechanisms of crawler-type vehicles. Operations performed automatically by the machine include milling, boring, facing, drilling, and chamfering.

Automatic Operation

With the machine set up for a particular part, the operator manually loads a rough casting into a fixture carried on a movable pallet. After clamping the casting, the operator momentarily presses twin *Start* pushbuttons. The rest of the operations are automatic.

The pallet is first traversed on slides to the required station farthest from the load-unload position. In discrete, although not necessarily equal, indexes, the pallet is then brought back through the workstations, stopping only at those where a machining operation is to be done on the part.

At each machining station the pallet is precisely located and clamped, and a hydraulic feed unit puts the tools through the following cycle: Rapid approach, feed, positive stop, dwell, and retract. Part production times are a function of the number of machining stations used and the lengths of time required at each station. Changeover from production of one part to production of another requires setting a selector switch on a control console, changing the tools and workholding fixtures, and resetting positive feed stops on the heads if required.

Mechanical Design

Three building-block type hydraulic feed units carry all the cutting tools. Head *H*1 is a vertical feed unit with two spindles. These spindles carry carbide milling cutters and have outboard supports and provision for adjustment for wear and cutter sharpening. Head *H*2 has nine spindles: One each for rough boring and spot facing, finish boring, and hollow milling, and six for drilling. Head *H*3 has eight horizontal spindles, all currently tooled for drilling. These feed units can cycle individually or together.

The machine includes a built-in coolant tank and a chip cleanout trough running the length of the machine. A drag-link conveyor discharges chips from an elevated flight at the rear into tote bins.

Final positioning of the pallet at a given workstation is accomplished mechanically through a system of shot pins, *Fig.* 3. These work in conjunction with a shot pin rail attached to the pallet. After the pallet has been located approximately through electrical control means, one of the shot pins enters an appropriate hole in the rail to position the pallet accurately. A rounded end on the pin facilitates its entry into a hole.

By arranging the holes in two parallel lines longitudinally along the rail, short intervals between successive indexes can be provided without overlapping of holes as would occur if a single line of holes were used. A pair of shot pins is used for each line of holes in the rail. The shot pins in a pair are spaced so that each time a pair is operated, only one of the pins will contact the shot pin rail. Hydraulic cylinders mounted on the machine frame actuate the shot pins.

When a pallet has been located in its final position at a workstation by insertion of a shot pin in a hole in the rail, the pallet is automatically clamped in place. This relieves the shot pin of having to resist any forces such as machining loads. To accommodate part design changes, or different families of parts, the shot pin rail can be removed from the pallet and replaced by one having shot pin holes bored for the new locations.

Programming Controls

Routing of the pallet to desired workstations, and cycling of the machining units, are controlled by an

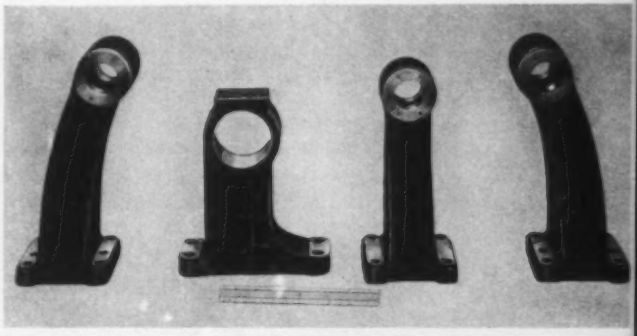


Fig. 2—These carrier-roller supports are typical of parts that can be run on the automatic machine. Currently, six parts of this type are being machined on the unit.

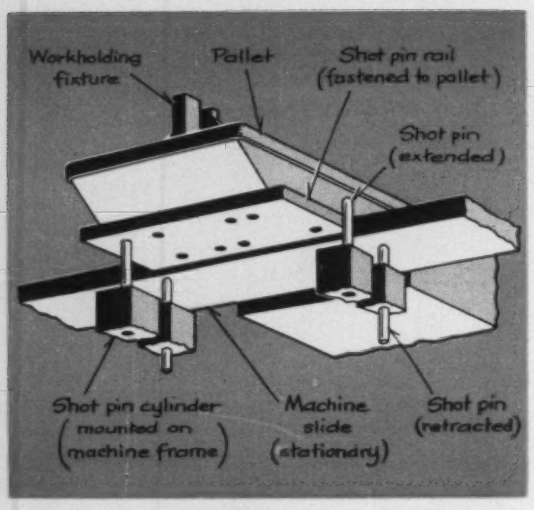


Fig. 3—Two pairs of shot pins are used for final positioning of pallet at a workstation. Shot pins *A* and *B* comprise one pair, and operate in conjunction with outer row of holes in shot pin rail attached to pallet. Pins are spaced apart so that when actuated together by hydraulic cylinders, either shot pin *A* or *B* will engage the rail. Shot pins *C* and *D* comprise second pair, and engage holes in inner row on shot pin rail. By using two rows of holes, short intervals between indexes can be provided.

electrical circuit that includes 20 limit switches (one for each station) and a selector switch. The limit switches are mounted on the machine so as to be operated by dogs on the pallet, *Fig.* 4. The selector switch is mounted on a control console associated with the machine.

Positioning of the selector switch for production of a given part activates certain of the 20 limit switches in the control circuit. The limit switches that are thus activated are those corresponding to the workstations at which machining is to be done. The selector switch has six positions so that six combinations of pallet routings are possible. For the various parts currently being machined, from six to eight workstations are used per part, *Fig.* 5. Since the requirements for the various parts are different, all of the 20 stations are being used.

When a dog on the pallet actuates one of the "live" limit switches, the pallet is stopped at the corresponding station. By means of electrical interlocking, the shot bolts are then advanced, the pallet is clamped in place, and the appropriate machining head is cycled. The pallet is then freed, and can proceed to another workstation or back to the unloading point. At some stations two machining heads can be operated sequentially. In other cases, interlocking is such that a given machining head must have come to depth at a previous station before it can cycle at a subsequent station. For example, rough boring must be completed before finish boring.

Selection of the operating cycle for a given part can be made only when the pallet is at the loading position (the selector switch on the control console can be key-operated, with control of the key resting with a tool engineer, set-up man, or tool crib attendant). The selector switch is electrically interlocked so that once set, and a cycle started, the machine will continue with that cycle. If the switch position is changed during a cycle, that cycle will be completed and then the machine will arrange itself for the new cycle.

The type of cycle is selected by means of a three-position selector switch on the control console. Its positions are *Auto* for automatic cycles, and *Main* and *Aux* for manual cycles.

Two pilot lights are provided on the console for each station. An upper row, labeled *Stations Effective*, is controlled by the selector switch and indicates the stations that are effective for the part being produced. A bottom row of lights, labeled *Pallet Location*, indicates the actual positon of the pallet during a cycle.

A pilot light, labeled *Effective*, is provided for each of the head units. Whenever one of these lights is on, the indicated unit must complete its cycle before the pallet can be indexed to the next station. The shot pin that is effective for any given station is also indicated on the console by a pilot light.

If the machine stops during a cycle, the pilot lights indicate the last step completed. When the cause of

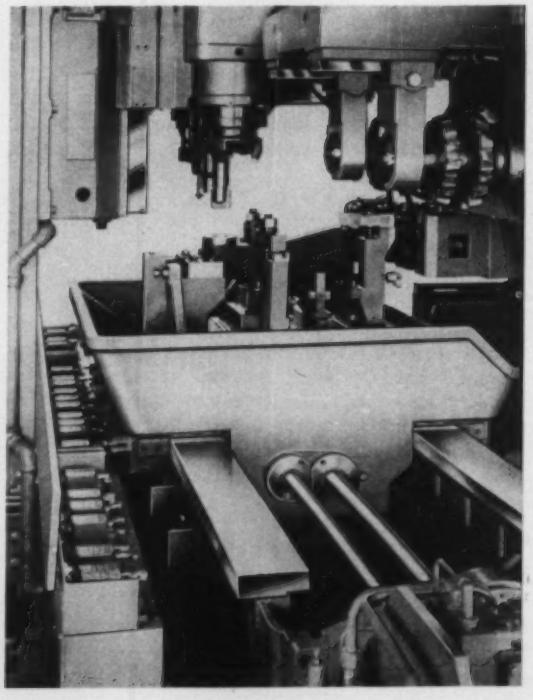


Fig. 4—Limit switches in row at left are actuated by dogs on pallet as pallet traverses machine bed. A selector switch connects various of the limit switches in the control circuit, providing a means of programming the machine. Each position of the selector switch corresponds to a particular part. View is of opposite end of machine from operator's position and control console.

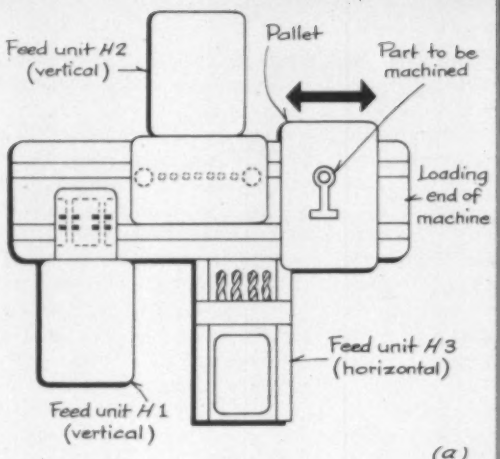


Fig. 5—Schematic plan view of machine shows arrangement of basic machining units in relation to machine bed (*a*). Operational sequence chart illustrates abbreviated form in which programming information may be kept (*b*). Machine cycle for automatically processing part number 3 is detailed in (*c*).

(*b*) OPERATIONAL SEQUENCE CHART

Part No.	Workstation 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	H1				H1				H2	H2	H3	H2		H3	H2					Load & Unload
2				H1				H1	H2	H2		H2	H3		H2		H3			
3		H1					H1		H2	H2		H2 H3			H2					
4			H1		H1					H2		H2			H3			H3		
5				H1		H1				H2		H2				H3			H3	
6		H1					H1		H2	H2		H2 H3			H2 H3					
Effective Shot Pin	C	A	C	A	C	A	C	C	C	C	B	B	B	B	B	D	B	B	D	

(*c*) DETAILS OF AUTOMATIC OPERATION FOR MACHINING PART No. 3

- Load fixture at Station 20 and actuate Start buttons.
- Pallet travels to Station 2.
- Feed unit H1 cycles (milling operation).
- Pallet indexes to Station 7.
- Feed unit H1 cycles (milling operation).
- Pallet indexes to Station 9.
- Feed unit H2 cycles (hollow milling and facing operation).
- Pallet indexes to Station 10.
- Feed unit H2 cycles (rough boring and facing operation).
- Pallet indexes to Station 12.
- Feed unit H2 cycles (finish boring operation) if unit H2 has gone to depth at Station 10, then feed unit H3 cycles (drilling operation).
- Pallet indexes to Station 15.
- Feed unit H2 cycles (drilling operation).
- Pallet indexes to Station 20 and machine stops. Machined part is unloaded.

stoppage has been corrected, the operator need only be sure all units are retracted and press the *Start* pushbuttons. The machine will then complete the interrupted cycle and stop.

Maintenance and Setup Cycles

When the cycle selector switch is turned to *Main*, pushbuttons on the operator's console are effective. A pushbutton is provided for each movement of the machine. Indexing, clamping, shot pins, and heads can be cycled from the console. A pilot light is provided to indicate the completion of each movement. Pressing the pushbuttons in sequence from left to right as they appear on the console will take the machine through the proper cycle for each station.

When the cycle selector is turned to *Main* and an emergency control selector is turned on, the pallet can be jogged in either direction after it has been advanced to the first effective station. When positioning the pallet at any station other than the first effective station, it must approach the station in the backward direction.

When the cycle selector is turned to *Aux*, pushbuttons at the various units are made effective, and pushbuttons on the console, except the *Stop* button, are made ineffective. A feed unit can then be jogged in either direction by holding both its *Forward* and *Reverse* buttons depressed and momentarily releasing the

THE AUTHOR

MICHAEL ZAJAC, vice president in charge of engineering at Buhr Machine Tool Co., is eminently qualified to discuss current developments in automatic, multioperation production equipment, having been chief engineer of this company for 2½ years prior to assuming his present position.

Zajac got his start in industry with Ford of Canada, in methods engineering. After 13 years in this field, he acquired 10 additional years of machine tool experience. His professional affiliations include membership in the American Society for Metals and the Engineering Society of Detroit.

button for the direction opposite to the desired travel. A unit can be stopped at any point by depressing both buttons momentarily while it is in motion.

As an added safety feature during periods of maintenance or setup, any unit selector switch can be turned to *Off*. This stops the spindle motor and prevents any motion of the unit.

Versatile Machine

As originally conceived, this machine was intended to handle four different parts. During construction, specifications were changed several times — first to handle six parts, then five, then six again, but not the same six. In fact, some of the original four parts have been supplanted by others.

Versatility is such that, in addition to changing and adding programs during construction, individual changes could also be made in various parts: Over-all length was shortened, boss thickness increased, boss diameter changed, flange thickness decreased, flange height decreased and bearing bore altered.

These part design changes could be handled by the machine because it was conceived as a system for programming operations anywhere within the available pallet travel (90 inches on this machine). In effect, it is the process rather than the machine that is automated. This same concept will permit use of the basic machine for production of other parts in the future. Workholding fixtures and tools used in the heads can be changed, dog adjustment ranges can be altered, and new parts can be easily handled.

If future parts are radically different from those now made, it might be necessary to rewire the selector and limit switch circuits. The parts for which the machine can be reprogrammed, however, are limited only by the available volume within the working space.

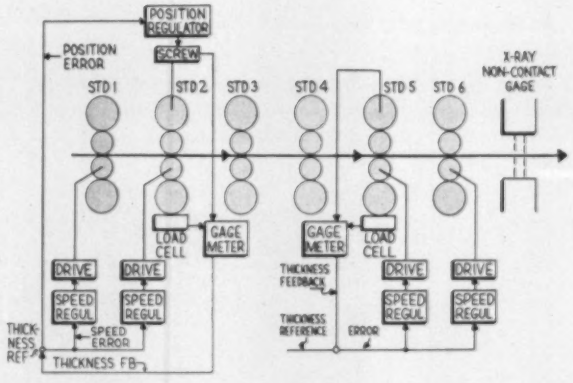
The flexibility of operation and versatility as to parts that can be run with equipment of this type suggest that its adoption can be justified even by relatively small-lot producers. Return on capital investment should exceed that possible from single-purpose automatic machines that employ complex position sensing and control means.

automatic control of steel strip thickness

SYSTEM for controlling the thickness of steel strip and plate on hot strip mills, reversing cold mills, and tandem cold mills has been developed by the Industry Control Dept., General Electric Co. The equipment, known as the gage meter system of automatic gage control, employs a patented thickness measurement system. Using the mill itself as a "flying micrometer," the gage meter system calculates metal thickness, and then automatically adjusts roll opening or interstand tension to provide a uniform finished product.

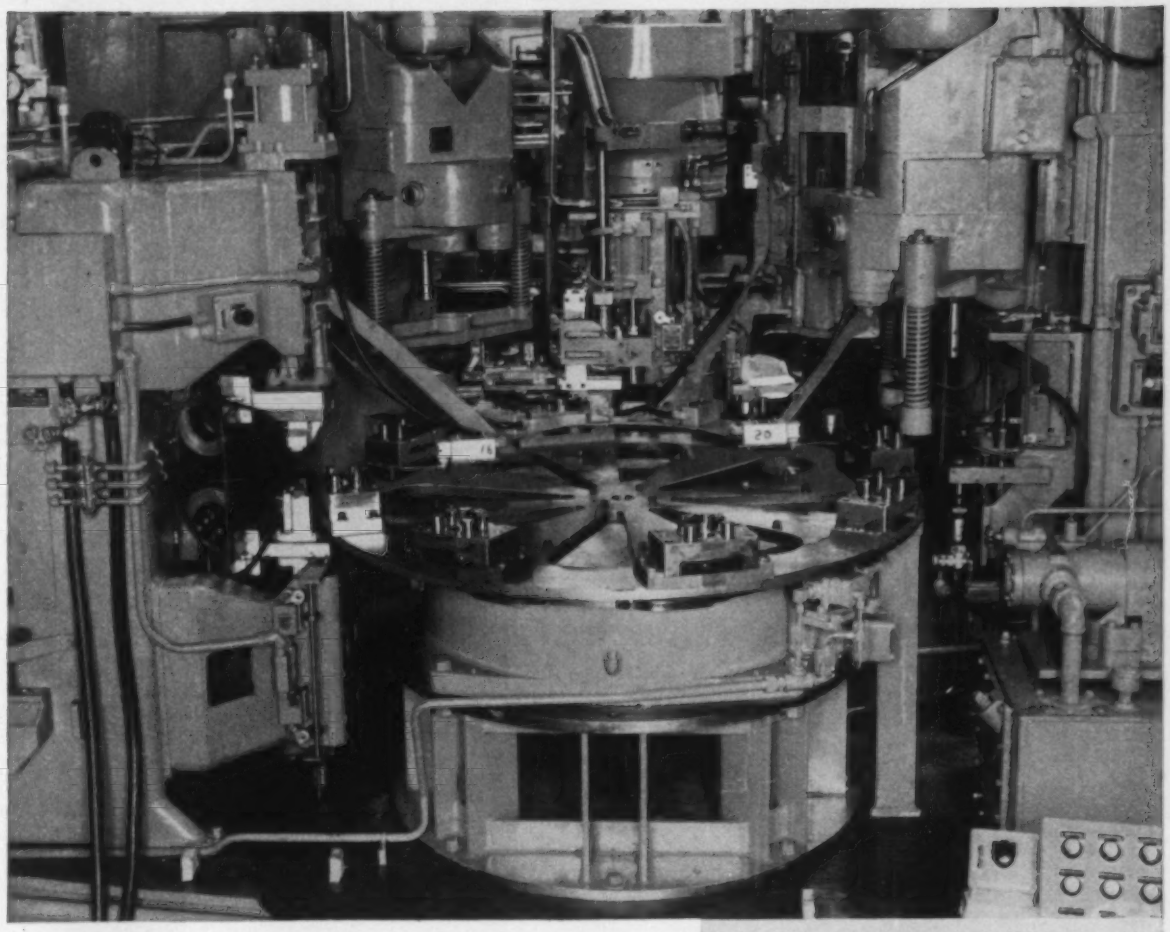
The system is based on the fact that roll separation is equal to the ouput of the strip thickness. The gage meter system computes roll separation on the basis of the unloaded roll opening plus the added roll opening caused by deformation of the rolls during operation and minute changes in the mill housing under load. The change in roll opening due to mill loading is known to be a linear function of the rolling force, based on Hooke's Law that below the elastic limit the stress is directly proportional to the strain.

Schematic of a 6-stand hot strip mill illustrates the operating principles of the gage meter system. A roll screw position regulator and a load cell are installed on the second stand. A second load cell is placed on the fifth roll, and all six rolls are controlled by speed regulators. A position indicator driven by the second stand screw initiates a signal proportional to the roll opening with no metal in the mill. The load cell under the screw measures the separating force of the roll and provides a signal proportional to the change in roll opening due to loading. When the two signals are fed into a scaler, adder, and amplifier, the resulting output is proportional to the roll deviation or metal thickness.



The first gage control is placed on the second stand so that it will have the opportunity to correct the tail end of the strip as tension is lost between the first and second stands. Operating on tension between the fourth and fifth stands, the gage meter control on the fifth stand feeds metal of essentially constant thickness into the last stand, thereby enabling the sixth stand to make a constant reduction and feed out a constant shape.

Since the system is subject to slowly drifting errors caused by roll wear and roll expansion due to thermal changes, a compensating x-ray gage is required to reset references on the gage meter system. Because of the nature of its role in this application, the x-ray gage can be installed remote from the last stand where the possibility of physical damage is greatly reduced.



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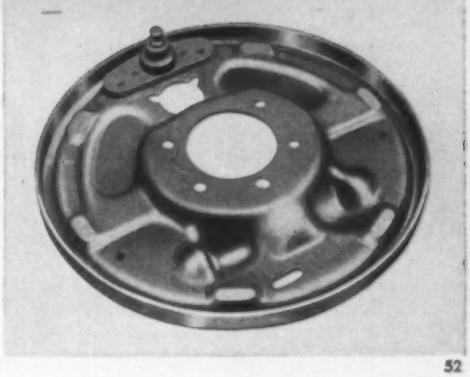

52

Loading, resistance welding, hydraulic reaming, hopper feeding, pressing, hot upsetting and hollow milling are the seven operations—performed automatically—on automotive brake backing plates by this one National Electric Dial Feed Machine. The installation of this unit, by an automobile manufacturer, not only released eight machines for other production, but saved a corresponding amount of floor space as well.

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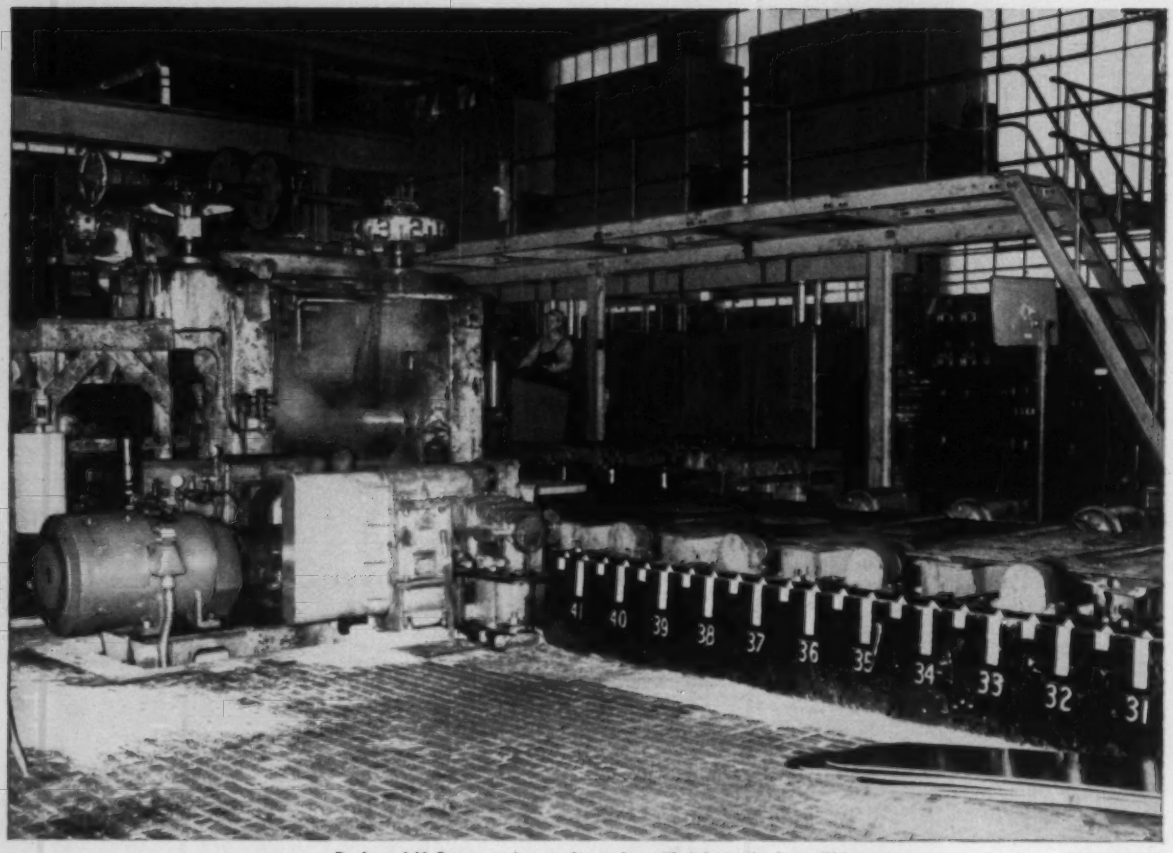

Packaged M-G sets and controls are located right at the hot mill in Revere Copper and Brass, Incorporated's New Bedford, Mass. plant

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AUTOMATION

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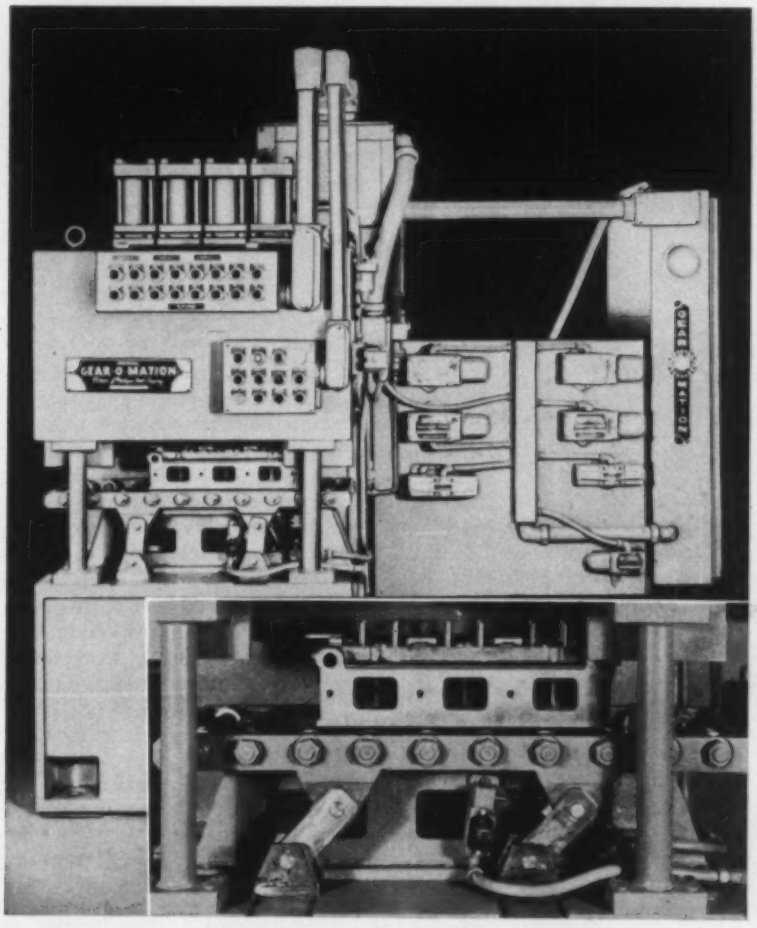
Semiautomatic Machine Assembles Valve Guide Bushings

HYDRAULICALLY operated semiautomatic machine designed by **Gear-O-Mation Div., Michigan Tool Co.**, 7173 E. McNichols Rd., Detroit 12, Mich., is capable of pressing valve-guide bushings into any one of five different engine cylinder heads. The heads are for two, three, and four-cylinder diesel engines of two types—in-line and V-type. The three and four cylinder models have either two or four valves on each cylinder. To insert bushings, an interlocked electric and hydraulic circuit of the machine controls four rams individually. Each ram normally press-fits two bushings for each engine cylinder, but can be fitted with special ram guides to insert four bushings.



Operational Sequence

Cylinder heads with the bushings held in place by a pilot plate are manually roller-fed to a hydraulically operated end-stop positioner. Positioning is adjustable to properly locate each of the different cylinder heads. In operation, the worktable lowers on a linkage to the press position where it actuates a limit switch which controls the ram action. The rams to be actuated are pre-designated by a selector switch, and only those rams that are so selected will lower to press-fit the valve-guide bushings of the particular cylinder head being run. When the rams return automatically to their retracted position, they actuate a pressure switch-controlled circuit that raises the worktable to an *Exit* position. The operator then moves the work onto a roller conveyor that feeds it to a transfer machine.

The rams are set to move down in rapid sequence, but they can be operated simultaneously. The force (between 850 and 1300 lb) exerted on the bushings by the rams is adjustable to meet varying requirements. If a bushing is pressed in with less than a predetermined force, or is improperly positioned, visible (signal light) and audible (bell) indicators are actuated.

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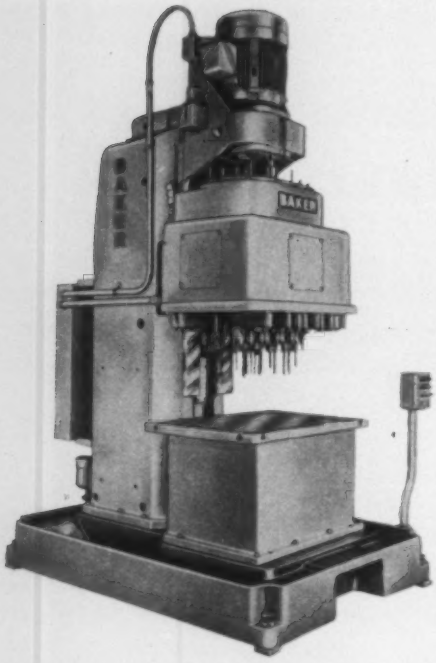

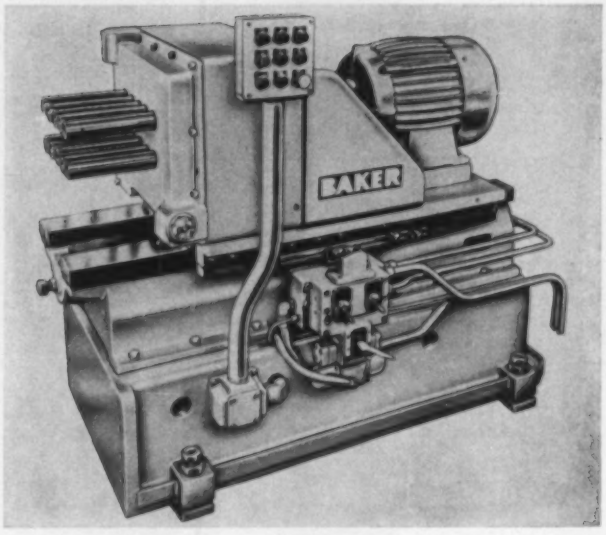

Multispindle Drilling and Tapping Units

Item 402

Line of hydraulic machines for multispindle drilling and tapping is designed for use with stock adjustable spindle heads or fixed-center spindle heads. Both vertical (left) and horizontal (right) machines are included in line. Accessory indexing tables are available that can be mounted on the bases of the machines.

Interchangeability of components and spindle heads was emphasized in development of the machine line. For the basic machines, a total of 21 different sizes of standard adjustable spindle head units can be applied. Fixed-center heads, with standard housings and gear trains, can be bored for special requirements. 27 sizes are in stock.

Vertical units are available with way widths of 12, 18, and 24 inches and strokes of 18 to 27 inches. Horizontal units have the same way widths, and strokes of 18, 27, and 40 inches.

In addition to complete machines, bare horizontal feed units can be purchased for construction of special machines. Each is standard, with way widths of 12, 18, and 24 inches and 18, 27, and 40-inch strokes. Units can be fitted with the fixed and adjustable spindle heads described. **Baker Bros. Inc.**, 1000 Post St., Toledo, Ohio.

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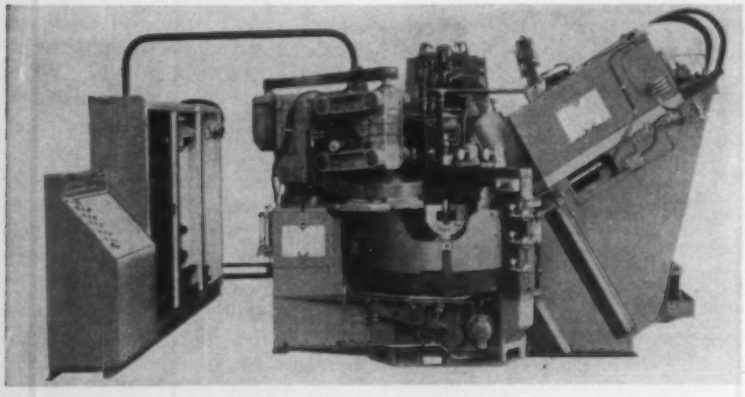

Four-Station Rough & Finish Grinder

Item 403

Of particular interest to the mining, quarrying, and oil-field industries, grinder is capable of rough and finish grinding head-bearing sections of rock bits and similar parts in sizes from 3½ to 9⅞ inches. Unit has three workstations and a load and unload station. The machine cycle is automatically controlled from a console. This console has signal lights which provide a visual indication of the work status.

In operation, after the part is loaded, the top of the pin is ground flat at the first workstation. At the next workstation, the pin diameter is rough-ground during the first part of a two-step cycle. The pin and the adjacent shoulder are rough-ground, and the pin is chamfered, at the second portion of the cycle. At the third workstation, the pin diameter and shoulder are finish-ground.

Automatic sizing is incorporated in the machine to compensate for wheel wear. Following each operation, pieces are automatically gaged and the gaging head signals the machine to feed in as required. Features of the machine include: A precision grinding head with a hydraulic cylinder feed working against an adjustable lead screw stop, limit switches to control and

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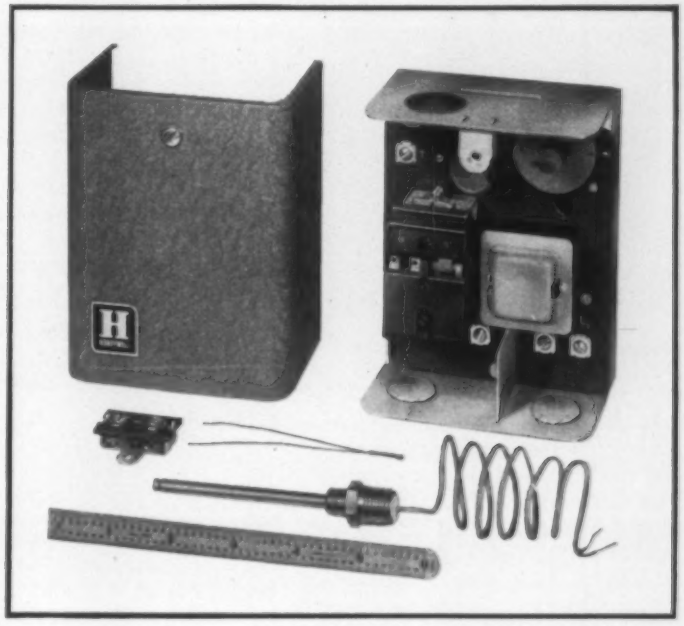

Versa-Tran relay with three types of thermistor sensors.

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interlock all operations, and a coolant separator to maintain a high level of grinding efficiency. **Mattison Machine Works**, Rockford, Ill.

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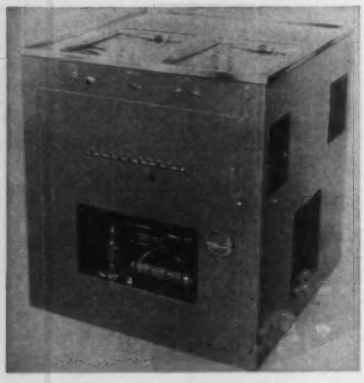

Ultrasonic Cleaner

Item 404

Model GW-6 has two stainless steel tanks for ultrasonic cleaning and rinsing of parts and assemblies. The solution in each tank is continuously circulated and filtered to remove particles of 2-5 micron size or larger. Each tank is activated by multielement magnetostrictive transducers operating at a frequency of approximately 20 kcps. Tanks measure 10 by 14 by 10 inches. **Blackstone Corp.**, Jamestown, N. Y.

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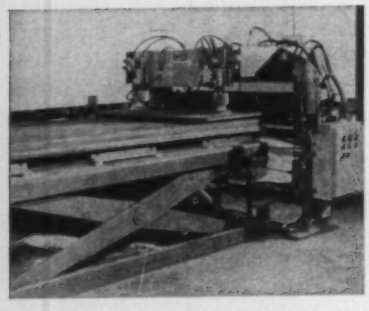

Vacuum Panel Feeder

Item 405

Machine is designed to feed panels to sanders, coaters, automatic conveyors, and other processing machinery. It can feed the panels at preset speeds or it can be used for bump feeding as in sanding. In operation, as a stack of panels is moved onto the roll case of a lift, an operator pushes a button to start the pinch roll motor, vacuum pump, and lift. The lift raises the material to contact the vacuum cups. The cups seal and lift a panel. When it is in the *Up* position, the upper carriage moves, placing the end of the panel between nip rolls. The vacuum cups leave the panel and move back into position over the stack. After the back end of the preceding panel is in the nip rolls, the vacuum cups will pick up the next panel. The last panel in the stack rests on a limit switch. When the switch is released by removal of this panel, the lift returns to the *Down* position. After another stack is placed in position, the automatic cycle begins again. **Union Tool Corp.**, Warsaw, Ind.

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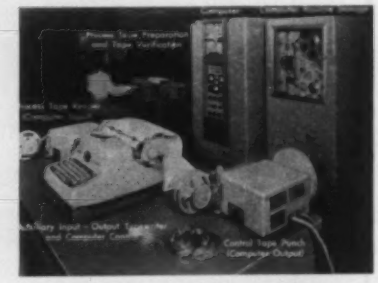


Tape Preparation System

Item 406

Numerical control tape preparation system prepares tape for automatic machining of parts with two and three dimensional contours and free form point-defined curves. The system takes dimensional and machining information from engineering drawings and produces a coded punched control tape for direct control of machine tools. It can be used to prepare machine control tapes for machining intricate three dimensional parts which contain pockets, flanges, tapers, contours, and grooves. Such parts include turbine blades, cams, molds, forging and stamping dies, templates, integral panels, and forged fittings.

Equipment which comprises the system includes: A prepared form (process sheet), a Flexowriter typewriter with a tape punch, a general purpose digital computer, and a set of computer programs. To begin the tape preparation, a process sheet is prepared. This sheet lists the coordinate dimensions of the part in the desired cutting sequence. It contains information such as machine feed rates, cutter diameter, and tolerance. The process sheet is then reproduced on the Flexowriter, which simultaneously prepares a punched process tape and condenses information from the sheet into a form suitable for use as input to a computer. Verification of process tape accuracy is accomplished by inserting it in a tape reader unit attached to the typewriter. A second transcription of the process sheet is made to produce a second process tape. If the two codes compare, the tape punch will operate and punch a verified second process tape. If the codes do not compare, the punch will not operate and the operator can locate the error.

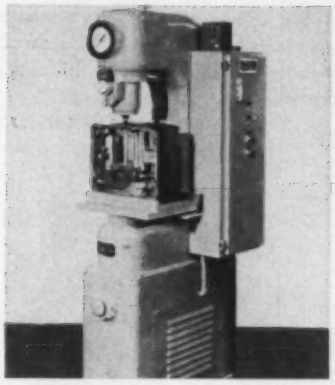
The verified process tape is then inserted into a tape reader that operates in conjunction with the computer. The tape is read by the computer, which automatically produces the control tape in the form required for machine control. An interpolation function performed by the computer establishes the required spacing of intermediate points on curved sections in accordance with the tolerance specified on the process sheet. Since the cutter path between sequential points on the control tape will be along a straight line, the spacing of points will vary continuously so that the deviation from the desired curve will be sufficiently small to satisfy the tolerance and surface finish requirements. **Industrial Controls Section, Bendix Aviation Corp.**, 21820 Wyoming Ave., Detroit 37, Mich.

Circle 406 on Page 133

Hardness Tester

Item 407

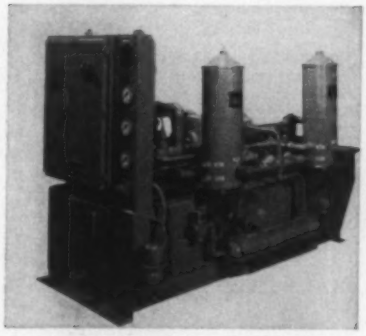
Unit features an interlocking part positon detector which assures that the workpiece is properly positioned before the Brinell hardness testing cycle can begin. A limit switch located in the table fixture must be depressed by the test part before a knee-actuated cycle switch becomes energized. After the limit switch and the cycle switch have been actuated, the tester applies the full hydraulically actuated load, signals the hardness, and withdraws the penetrator automatically. A gage on the front of the machine gives



a visual check of the applied load. Throat depth of the unit is 10 inches, the maximum vertical opening is 14 inches, and loads from 500 to 3000 kg can be applied.

Colored lights on the machine indicate the relative hardness of the part. When a part is too hard, the ball will not penetrate deeply enough and a yellow light will flash. If the ball penetrates too far, the material is too soft and a red light flashes. Acceptable parts are indicated by a green light. The machine can distinguish a difference in diameter of ball impression of 0.1 mm. Limits to be indicated by the lights are selected by using pieces of known hardness. **Steel City Testing Machines Inc.**, 8817 Lyndon Ave., Detroit 38, Mich.

Circle 407 on Page 133



Coolant Supply System

Item 408

Designed to supply coolant for deep hole drilling and trepanning, system is available in three capacities—7.5, 22.5, and 37.5 gpm, with pressures to 1000 psi. Equipment in the system includes: Heat exchangers, water control valves, low level alarm, variable displacement high-pressure pump, chip basket,

everything you need to fasten anything with nuts

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TOOLS FOR screwdriving nut running FASTENING

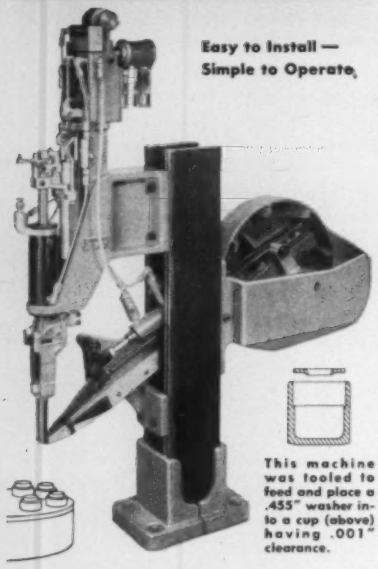
Circle 681 on Page 133

FOR TIMESAVING ASSEMBLY OF SMALL PARTS

DIXON

Auto-Positioner

IN FOUR STANDARD MODELS



Easy to Install — Simple to Operate

This machine was tooled to feed and place a .455" washer into a cup (above) having .001" clearance.

- *New Positive-Acting Feeder*
- *Automatic Sensing Device*

The Dixon Auto-Positioner is a compact, air-operated automatic assembly machine for parts from 1/16" to 2" size at speeds up to 6000 cycles per hour. It is furnished as a fully automatic station for use at a dial or in-line transfer table, or as a self-contained machine with pedestal and fixture table. There are four models, providing a selection of equipment to suit your requirements.

Dependable, Accurate, Compact

The new parts feeder is simple, compact (only 6 inches wide), and efficient. It provides positive advancement of the part into the chuck; it has a straight track and a positive-acting escapement; and it requires no separate motor or vibrator. Automatic sensing assures quality control. It interrupts the cycle when a part is missing or improperly assembled.

Standard Equipment, Easily Retooled

The chuck, positioning punch, and feeder tooling are easily modified or replaced for other jobs. Compactness permits close nesting at multiple stations, cutting cost of fixtures, dials, or transfer devices.

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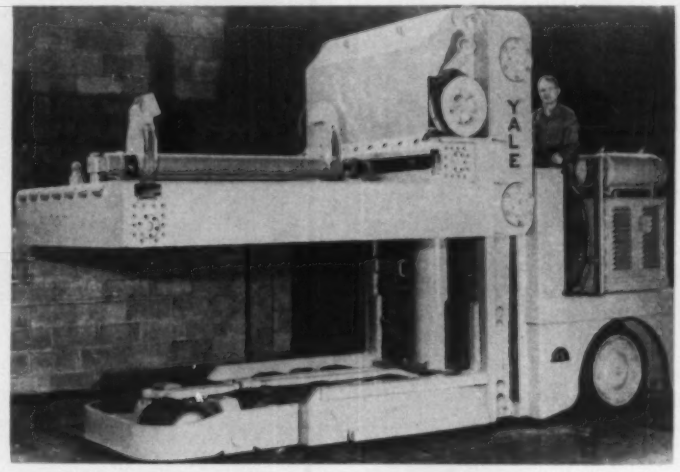
Equipment for Automatic Parts Handling and Assembly

Circle 682 on Page 133

electrical control panel, gage panel, and solenoid cutoff valve. System has a four section settling tank. Each tank has separate access covers and draining facilities. Disposable filters remove all particles larger than 5 microns. **Cardwell Machine Co.**, Franklin & 19th St., Richmond 11, Va.

Circle 408 on Page 133



Electric-Powered Die Handling Lift Truck

Item 409

Truck is capable of loading, either at the end or on the side, dies weighing up to 60,000 lb. Extensions are designed into the pusher bar for accurate die placement in press or storage. Hydraulically controlled bollards move dies sideways across the platform, and can be controlled individually or simultaneously. For end loading, an electric winch controls the operation. The truck has a lift of 75 inches. In its lowered position, the truck platform is 18 inches from ground level. Unit features dual controls on either side of the operator's platform. **Materials Handling Div., Yale & Towne Mfg. Co.**, 11000 Roosevelt Blvd., Philadelphia 15, Pa.

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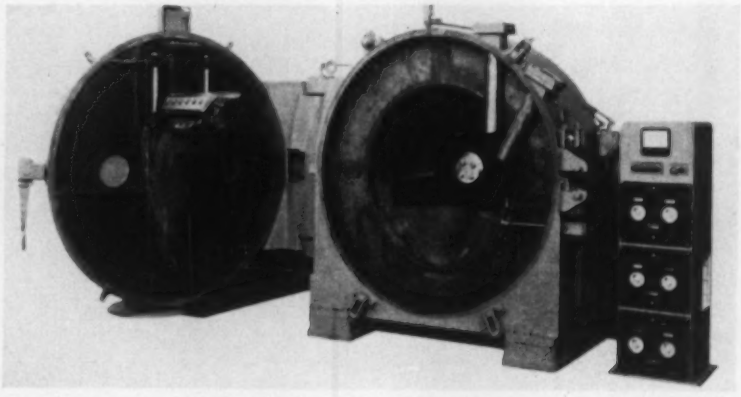


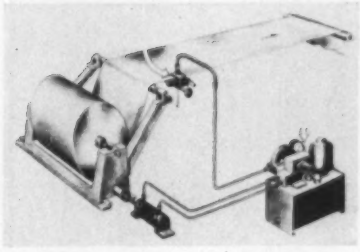
Continuous-Filtering Centrifugal Separator

Item 410

Machine is designed for separating and washing filterable liquid-solid slurries such as titanium sponge. Machine is powered by a 125 hp motor, has a 66-inch diameter drum, and can handle loads up to 20.5 cu ft of material per batch. Separator can accelerate to 125 to 640 rpm in 40 seconds by means of a variable speed, water-cooled, eddy

current brake-clutch drive. Features of Model HS-66 are that all internal parts coming in contact with corrosive liquids are rubber lined, and housing is vapor tight. **Chemical Machinery Div., Baker Perkins Inc.,** 1000 Hess, Saginaw, Mich.

Circle 410 on Page 133



Web Guide Control

Item 411

Device uses a noncontact method of edge detection, is capable of guiding heavy steel strip as well as delicate films such as polyethylene. It is controlled by a relay which operates on a hydraulic jet principle. This provides a completely enclosed and pressurized hydraulic power circuit utilizing hydraulic pressures from 50 to 750 psi. The relay can be installed in any position or location with respect to the hydraulic pump and reservoir. Air supply for the detector unit can be plant air or any small blower that is capable of delivering 2 cfm at 6 to 8 inches pressure.

The edge detector operates by means of a constant low pressure stream of air passing across a gap and striking a receiving opening that is connected to the outside of a regulator diaphragm. A web edge moving through the gap in the detector partially interrupts the air stream, affecting the air pressure on the diaphragm. Whenever the opposing forces of the diaphragm and an adjusting spring are out of balance (caused by an error in the edge position), the relay is actuated and a hydraulic piston moves the reel or roll to correct the error and restore the balance of the forces. In the illustration shown, the device is controlling payoff, where the web is being guided into an operation or a process. In this case, the edge detector is mounted stationary and the reel and stand are moved to bring the web edge to the desired

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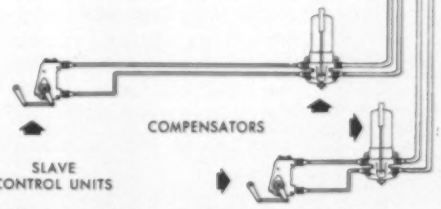

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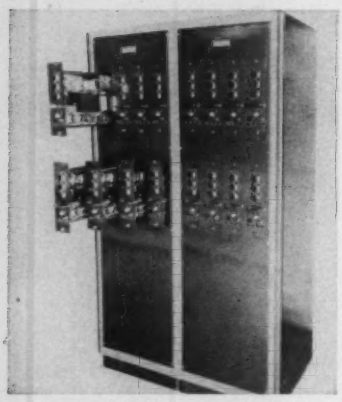
Circle 683 on Page 133

position as it enters the process. Windup and process web control can also be applied. **North American Mfg. Co.**, 4455 E. 71st St., Cleveland 5, Ohio.

Circle 411 on Page 133

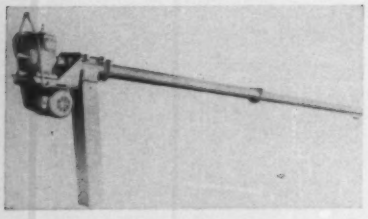


Gas Analysis System

Item 412

Unit is adaptable for continuous gas leakage monitoring as in unattended pump and gas compressor stations, tank farms, and solvent storage areas. Analyzer shown is a 16 head modular system with individual slide-out type control chassis. It uses diffusion type heads, which is said to eliminate the need for sampling pumps, rotameters, needle valves, and flow failure devices. The circuits can be arranged so that one or more detection heads are connected in series to a single control chassis and control relay. Each head can also be provided with an independent control chassis and control relay. **Davis Emergency Equipment Co.**, 45 Halleck St., Newark, N. J.

Circle 412 on Page 133



Screw Conveyor

Item 413

Device has a 4-inch screw, can transport materials such as coal, sand, gravel, wood chips, and chemicals. Conveyor is operated by electric motors rated from ½ to 1½ hp. A heavy steel worm welded to a solid steel arbor mechanically moves any bulk material up to 1¼ inches in particle diameter. Features of the unit include a motor overload switch and a heavy cast iron discharge spout with removable cover for inspection. Thrust bearing is mounted at top, or delivery end away from material. Each unit is constructed according to specific requirements for the application. **Canton Stoker Corp.**, 300 Andrew Place, Canton 1, Ohio.

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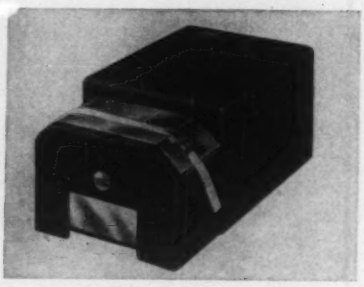

Tape Reader

Item 414

Instrument is designed to serve as an input or readout device for machines such as computers, calculators, and punched card equipment. It will also function as a transmitting device for printing telegraph equipment and as a control mechanism for tape-operated factory equipment. Model 28 LBXD can translate code combinations from a perforated tape into electrical impulses for sequential transmission or for simultaneous output on a parallel-wire basis. Reader will operate at 100 words per minute, and it can handle 5, 6, 7, or 8 level codes with tapes of appropriate widths. Unit has a three-position control—*Start*, *Stop*, and *Freewheeling*. The *Freewheeling* position is a control that frees the feed wheel to permit insertion of tape without raising the tape lid. Optional attachments which are available are: External start control of reading and sending, automatic tape stop, and taut tape control. **Teletype Corp.**, 4100 Fullerton Ave., Chicago 39, Ill.

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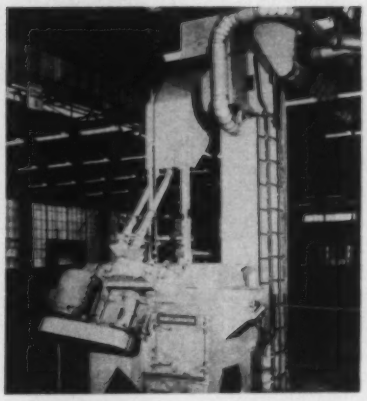

Descaling Machine

Item 415

Unit is designed for descaling wire rod and bar stock of all types. The addition of this machine to a line makes it possible to automatically perform functions such as blast cleaning, cold drawing, cold heading, or patenting in one continuous operation. The cleaning process is by means of an airless blast, which produces a shot-blasted finish suitable for coating and die lubrication. Up to 18 strands can be cleaned in one cabinet. Single strands can be handled at speeds up to 600 fpm. This process can be applied to ferrous and nonferrous hot rolled material in the production of cold drawn products. **Wheelabrator Corp.**, 1109 S. Byrkit St., Mishawaka, Ind.

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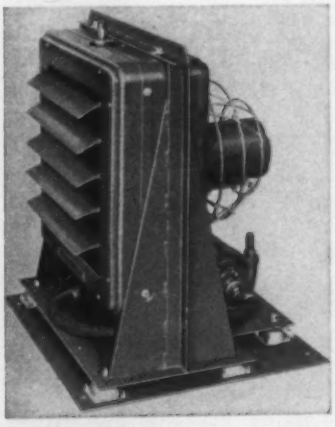

Fluid Cooler

Item 416

Unit consists of a water type copper coil, motor-driven fan, and mo-

tor-driven pump; is designed for cooling water-cooled type electronic tubes. Cooler is capable of extracting 13,500 btu per hour from water having a minimum flow of 5 gpm with maximum water exit temperature of 150 F and maximum ambient air temperature of 113 F. The coil and fan combination in Model 89B155 is supported by shock mounts, and the entire unit is supported on an integral base plate. All fittings that come in contact with water are copper or bronze. **American Blower Div., American-Standard,** P. O. Box 58, Roosevelt Park Annex, Detroit 32, Mich.

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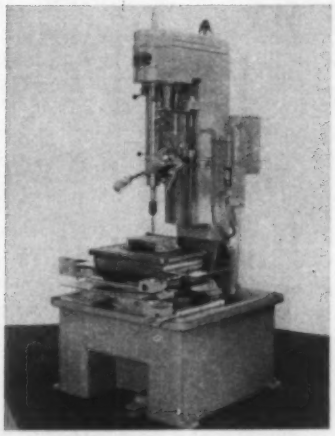

Layout Machine

Item 417

Equipment can perform layout operations such as center drilling, and drilling and reaming in parts which do not require jig boring tolerances. Machine has a heavy, ribbed base and a table of fabricated construction which includes a coolant trough. A removable riser block is supplied between the base and the upper machine column so modifications in working spindle height can be made to accommodate different layout tables. Machine is suitable for screw type tables, semiautomatic tables using gage blocks, and tables automatically programmed by tape or card.

Unit has an 8:1 speed ratio in direct drive and four feed rates from 0.0015 to 0.0075 ipr. Four heavier feed rates are provided in back gear drive. Features of Model 2 include: Infinitely variable primary drive, electrical speed changing device, and sealed bearings. Rated capacity of the machine is 1-inch in cast iron and 7/8-inch in mild steel. Spindle speeds with a 900 rpm motor are variable from 340 to 2700 rpm in direct drive and 85 to 675 rpm in back gear drive. With a 1200 rpm motor, spindle speeds are variable 450 to 3600 rpm in direct drive and from 112 to 900 rpm in back gear drive. **Edlund Machinery Co.,** 112 Huntington St., Cortland, N. Y.

Circle 417 on Page 133

Contour Milling Machine

Item 418

Hydraulically controlled machine, designated Hydroversion, is capable of either 360 degree or 3-dimensional milling. Table size is 28 by 64 inches with 36 inches of table travel. Cross travel of the cutting heads is 42 inches with vertical travel of 10 inches. Feed rates are up to 60 inches per minute in all directions. Unit has two 5 hp motor-driven spindles mounted on 12-inch centers; 24 spindle speeds

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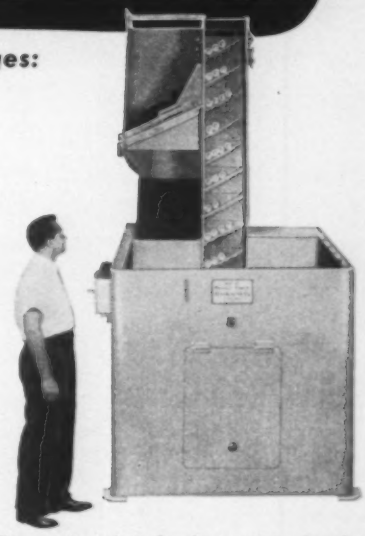

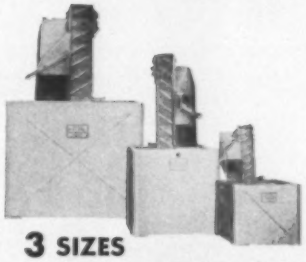

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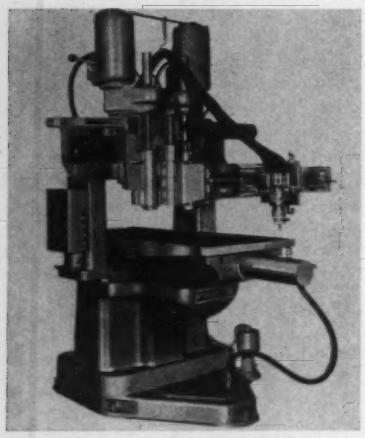
Circle 684 on Page 133



are available ranging from 87 rpm to 2600 rpm. Machine has a 50 gallon reservoir, a 5 hp electric motor, and a pump. The machine base has a coolant reservoir with a coolant pump mounted to the base. **Arrow Engineering Co. Inc.**, 11625 Walsingham Rd., Largo, Fla.

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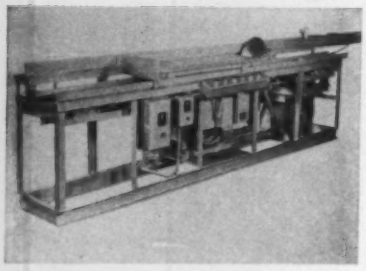

Dual Cut Rip Saw

Item 419

Applicable in the woodworking industry, rip saw is designed to cut lumber 3/8-inch to 1-inch in thickness and widths of 1-inch to 6 inches. Unit combines a hydraulically operated feed table, stock puller, and loader. The feed table can be varied in speed from zero to 100 fpm, either forward or reverse. The puller is mounted directly in front of the saws and the loader is mounted on a projected platform at the end of the machine.

In operation, the puller is energized after a cut when the table is reversed and pulls the boards from between the saws. This action permits the saws to dissipate any heat generated by friction due to distortion on a previous cut and to correct themselves for the next cut. The loader receives the boards from the puller. After the table has moved back approximately 15 inches, it ejects the boards from the platform to a pallet or truck. Power unit produces hydraulic pressure of 2000 psi, has a 4 gpm pump driven by a 5 hp motor. **Savage Engineering Div., Lithibar Co.**, 345 W. 14th St., Holland, Mich.

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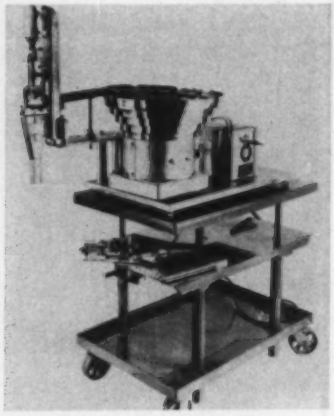

Vial Feeder

Item 420

Portable unit is suitable for handling plastic and glass containers and vials for subsequent filling operations. Bottles are delivered in a line from a vibratory hopper. An air operated device receives the bottles either neck or bottom first and readjusts them to deposit them all bottom-down. This action is positive; it does not depend on weight distribution in the bottles. Each stroke of the unit delivers one bottle; production rate is over 60 bottles per minute. **Chase Mfg. Co.**, 47 E. 19th St., New York 3, N. Y.

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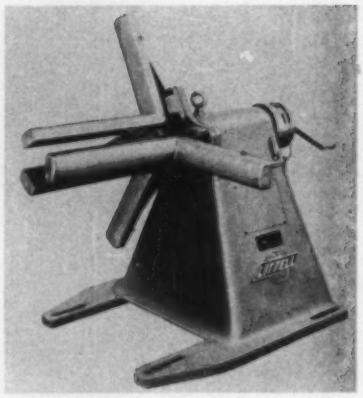
Automatic-Center Reel

Item 421

Automatic centering, 3-arm unwinding reel can accommodate coils up to 4000 lb, with 45 inches maximum OD and 18 inches maximum width; minimum ID can be 8½ inches. It is especially suitable for copper, bronze, brass, and tin plate coil stock normally coiled with small ID. An air brake, pressure regulator, and shutoff valve provide



adjustable spindle drag which prevents too-rapid unwinding in operation. A feature of the reel to eliminate excessive coil overrun is that when the equipment is shut off, full braking is automatically applied. **F. J. Littell Machine Co.**, 4101 N. Ravenswood Ave., Chicago 13, Ill.

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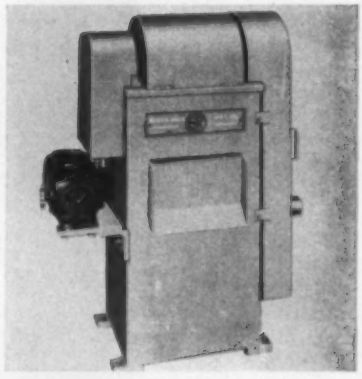

Rubber Band Cutter

Item 422

Machine is equipped with an infinitely variable device that can precisely control individual width cuts without the need for special gearing. Changes in band widths can be made while the machine is in operation. Model RBC has 3 revolving knives and 1 stationary knife. Widths from 1/16 to 1-inch can be cut at rates from 600 to 1800 cuts per minute. Unit is powered by a 2 hp, 900 rpm motor which develops 200 to 600 cutting rpm. Motor operates on 220/440v, 60 cycle, 3 phase ac. With the addition of a slitter unit, the machine can be adapted for dicing uncured

stock. **Black Rock Mfg. Co.**, 189 Osborne St., Bridgeport, Conn.

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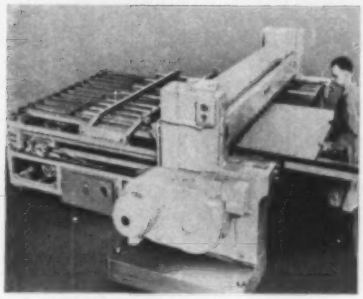


Shear Feeder/Gage

Item 423

Device is capable of accurately gaging and feeding sheet, coil, or strip stock from standard square shears. The unit (left in illustration) is mounted at the rear of a square shear and its electrical control system is integrated with that of the shear. An operator feeds the stock to the shear and the unit automatically advances the sheet to gaging fingers, operates the shear, and carries the trimmed sheet to a stacker unit. Production rate is adjustable from 80 to 300 fpm. When coil stock is being handled, a hump table unit is provided to operate in conjunction with the unit which feeds the stock continuously from the coil cradle.

An arrangement of V-belts acts as a transfer table—this table floats up and down with the action of the shear blade. By using a multiple side gage bar arrangement on the shear, two strips of different thickness can be sheared simultaneously. A visual measuring device with a handwheel and leadscrew control is provided for adjusting and setting length of the cut. By turning the handwheel, a carriage supporting the gaging fingers moves forward or back. A pointer indicates the length of cut on a scale. Pinch rolls which are effective over about two-thirds of the table area prevent stock from humping up while the machine is operating at high speed. **Press Automation Systems Inc.**, 25418 Ryan Rd., Centerline, Mich.

Circle 423 on Page 133

RICHARDS-WILCOX R&W AURORA ILL.

NEWS OF THE LATEST DEVELOPMENTS IN OVERHEAD CONVEYING SYSTEMS

NEW DEVELOPMENTS MAKE R-W "TWIN-TRAK"* AN EVEN GREATER BOON TO PRODUCTION "PROFIT-IMPROVEMENT"

Today, more so than ever before, manufacturers realize the need for better materials handling methods . . . a need that will not diminish but increase due to higher material and labor costs. In fact, with these rising costs and a business slow-down on one side plus sharper competition on the other, manufacturers are recognizing the fact that they *must* modernize materials handling methods to stay in business.

The development of the unique R-W "TWIN-TRAK" Overhead Automatic Dispatch System offered manufacturers an entirely new concept of efficient and economical handling of materials. This system consisting of one or more power tracks and as many storage tracks as desired plus switches, carriers and power-equipment, not only moves products from one point to another, but automatically and economically conveys parts or products to predetermined work stations from "storage banks" installed in the free overhead areas under the building trusses . . . releases valuable floor space for production operations. The economy and value of the R-W "TWIN-TRAK" System was immediately recognized by the manufacturing industry and many firms now have R-W "TWIN-TRAK" Installations.

R-W "TWIN-TRAK" SYSTEMS PROVE TO BE ECONOMICAL TO INSTALL, OPERATE AND MAINTAIN

The development of the R-W "TWIN-TRAK" System proved that it is not necessary to spend large amounts of available capital to realize greater efficiency in the handling of materials. Some manufacturers incorporated their existing R-W "ZIG-ZAG" Systems into an automatic "TWIN-TRAK" System . . . an important cost saving factor. Many manufacturers who, for various reasons, did not want to install a complete plant-wide system at one time have found it advantageous to have their "TWIN-TRAK" System installed in progressive steps . . . thereby attaining the desired end result of a complete system as capital is available. R-W "TWIN-TRAK" Systems are easy and economical to install, expand, alter or relocate.

NEW DESIGN DEVELOPMENTS AND SIMPLIFICATION NOW PROVIDE EVEN GREATER ECONOMY AND EFFICIENCY

The immediate success and acceptance of the R-W "TWIN-TRAK" Overhead Automatic Dispatch System spurred R-W Engineers to develop progressive and realistic simplifications of the many components to provide even greater economy and efficiency. Many of the already very effective carriers and manual or electronic switches were simplified and made more compact to save space and cost. Some of the original components were replaced by a new series of both manual and electronic switches that were developed to provide the utmost in positive and reliable operation. A new approach to the treatment of gravity was developed . . . this arrangement makes possible the absolute control of all carriers on gravity feed lines.

LEARN HOW AN R-W "TWIN-TRAK" SYSTEM CAN SOLVE YOUR MATERIALS HANDLING PROBLEMS.

An R-W "TWIN-TRAK" Overhead Automatic Dispatch System not only reduces operating and overhead costs and increases production efficiency but can actually pay for itself, in a relatively short period of time, out of actual savings. Write today for complete information or call your local R-W Sales Engineer.

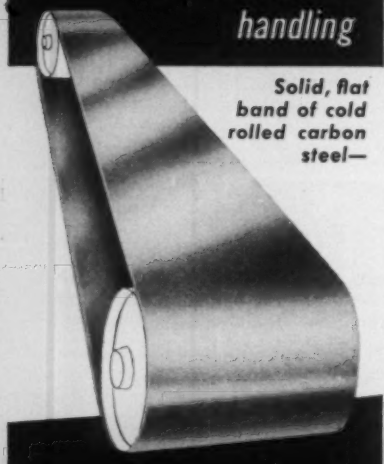
* "TWIN-TRAK" is the trademark of Richards-Wilcox Manufacturing Co., identifying its Automatic Dispatch System.

Richards-Wilcox MANUFACTURING COMPANY "MATERIAL HANDLING DIVISION"

417 W. THIRD STREET, AURORA, ILLINOIS • Branches in Principal Cities

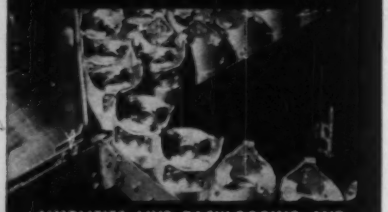
Circle 685 on Page 133

SANDVIK
Steel Belt
CONVEYORS
have SPECIAL ABILITY
for automated
handling



Solid, flat band of cold rolled carbon steel—

RESISTS OIL, HEAT AND ABRASION



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IN CANADA: Sandvik Canadian Ltd., P. O. Dr 1335, Sta. O, Montreal 9, P. Q.

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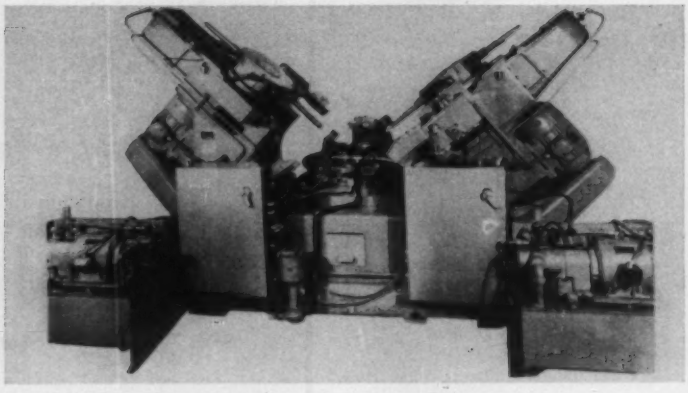


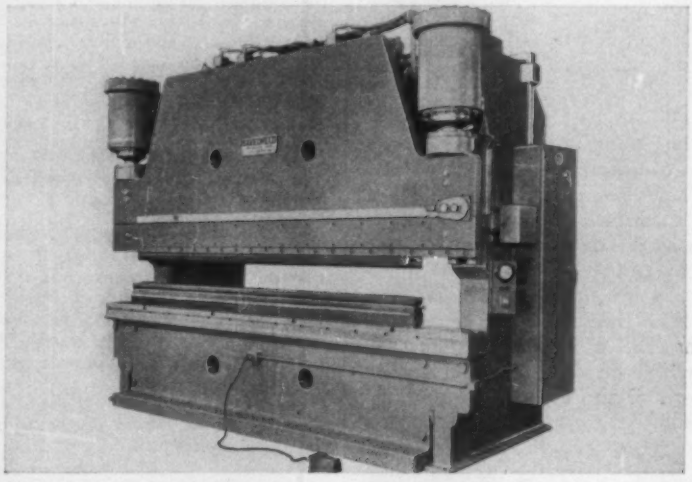
Multioperation Turret Machine

Item 424

Constructed from standard machine components, unit consists of a machine base, holding fixtures, and tools, is capable of carrying out a sequence of machining operations. With proper tools and fixtures, operations such as drilling, boring, counterboring, countersinking, tapping, reaming, and multiple forming can be performed. Spindles have individual preselected speed, feed, and depth stop; are automatically indexed and controlled. The machining cycle can include skip indexing or duplicate and repeat individual operations.

Unit is available with either six or eight spindle turrets and a variety of indexing tables. The hydraulic turrets and slides can be mounted horizontally or at any angle, on moving columns or in any position required by the work. Each unit has its own hydraulic power unit and each component can be individually controlled or the entire machine controlled from a central control panel. **Burg Tool Mfg. Co.**, 15001 S. Figueroa, Gardena, Calif.

Circle 424 on Page 133



Hydraulic Press Brake

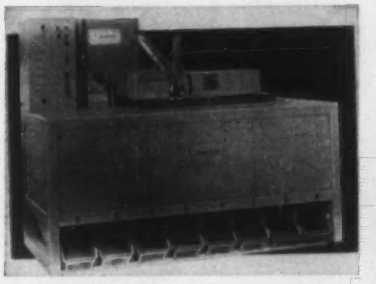
Item 425

Line of hydraulic press brakes is available in capacities to 2000 tons for bending mild steel from 10 gage to 2 inches thick, in lengths to 30 ft. The stroke, or ram travel can be adjusted for any length for a particular operation and between any points within the limits of the machine.

Power is constant during the entire stroke, which varies from 12

inches for the smallest brake (rated at 200 tons) to 18 inches for the larger machines. The ram can be started, stopped, and reversed at any point in the stroke. Either end of the ram can be tapered as much as 1/8-inch per foot of ram length. Electronic controls maintain the ram level or at a predetermined taper. **Cleveland Crane & Engineering Co.**, Wickliffe, Ohio.

Circle 425 on Page 133



Gear Counter, Sorter

Item 426

Machine automatically gages, sorts, and counts gears and similar parts into eight various size categories at the rate of 1200 parts per hour. Unit has interchangeable tooling which allows a variety of parts to be automatically handled. Gaging limits and speed can be easily adjusted. Machine is rated for 110 v ac, 200-250 w, and requires 70 psi air pressure. **Garrison Machine Works Inc.**, 515-525 Bannock St., Dayton 4, Ohio.

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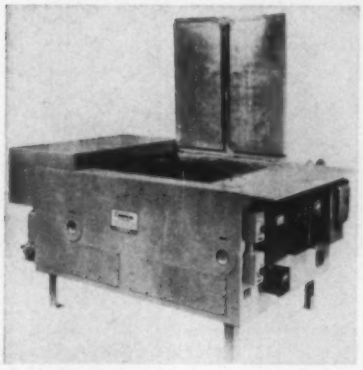

Plastic Dip Tank

Item 427

Device can be adapted to conveyorized systems to coat spare parts in strippable plastics for protection against damage or corrosion during storage or shipment. It is especially designed for heating ethyl cellulose and cellulose acetate butyrate strippable coatings, and other compounds which require a high, accurate operating temperature. Tank consists of a dipping compartment, premelt chamber, heating system, circulating and agitating pump.

The compound is melted by electric heat and is constantly agitated and circulated over the top of the dipping area. This action eliminates bubbles and provides a uniform coating. Proper temperature of the plastic compound is maintained under thermostatic control by a heated oil jacket which surrounds the compound chamber. A thermometer gives visual indication of the plastic temperature. **D. C. Cooper Co.**, 1467 S. Michigan Ave., Chicago 5, Ill.

Circle 427 on Page 133

The FEDERAL "55" gives you

OVERSIZE DIMENSIONS

Eliminates the need for larger and more costly equipment! Boosts production on big and bulky jobs!

Here's a press that will handle big, bulky jobs ordinarily requiring larger, more expensive equipment. Equipped with foolproof air clutch, its speed is increased many times, safely and with better control. Only the finest components are used in the "55". Workmanship, as in all Federal Presses, is unexcelled. Flywheel or geared types. Mechanical clutch standard. Call your dealer. Write for catalog.

Above
No. 55 Flywheel type—56-ton capacity
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FEDERAL PRESS COMPANY, 802 Division St., Elkhart, Ind.

FEDERAL Coin-Matic Toolmaker **PRESSES**
33 Years of Quality Construction

Circle 687 on Page 133

JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

HIGH SPEED STATIC SWITCHING *(at half the price)!*

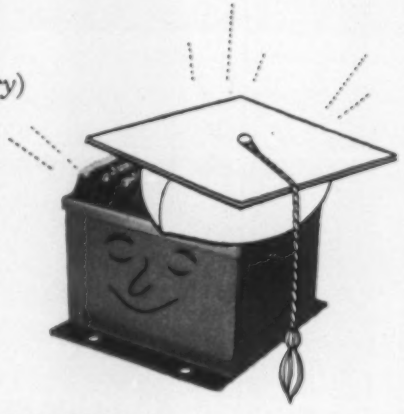
Sylvania Electric Products Co. engineers have just replaced an electronic relay, two small mechanical relays, a limit switch, and a separate power supply with a single CONTROL switching reactor which costs only half as much! They did it by taking advantage of the multiple windings on a CONTROL switching reactor—equipment which, because of its static operation, never wears out. Seems a high speed assembly operation on one of Sylvania's complex, highly automated vacuum tube production machines calls for a magnetic clutch to drive an index table. The clutch orients the work part by rotating it until current flows through two properly located contacts. Our CONTROL switching reactors not only cut costs in half, but do a job that the relays couldn't do: provide the ultra high speed signal necessary for proper switching in the automated assembly. *It worked so well Sylvania said, "I'll be switched!" We said, "With a 10,000 to one switching ratio, and ratings of 15, 75, 150 and 300 VA, most anything for control can be!"*

ONCE UPON A TIME . . . *(time delay, that is)*

Versatile, we are too! The same type of CONTROL switching reactors that work so well for this high speed switching also are used by Sylvania engineers to eliminate production breakdowns caused by relay failures in time delay circuits. Many pneumatic time delay relays on their production machines were dying young (three months of age or less). CONTROL switching reactors (which, naturally, never wear out) not only have no moving parts, but do a dandy job with time delay relaying, easily handling 6,000 closures per hour. Sylvania happily expects its CONTROL reactors to last twenty years. *"Right now," Sylvania says, "we're not too worried about what will happen after that." Need you be any more worried than they?*

LOGIC, MY DEAR WATSON *(. . . is elementary)*

Our educated switching reactors are masters at logic—the kind that gets built into automatic control operations. AND, OR, NOT, MEMORY and TIME DELAY—all are built into these high IQ reactors. By employing several isolated control windings, one reactor can translate many inputs (from push buttons, limit switches or other reactors, for instance) to any logic needed to switch very appreciable loads. And are they easy to use! Order standard units right from the catalog. You need no high falutin' systems engineering or auxiliary hardware (single purpose logic units, preamplifiers or transformers). *No wonder logical people order our logic-providing switching reactors. Can we send complete details to you?*



Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

Dept. A-54, BUTLER, PENNSYLVANIA

Circle 688 on Page 133

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 133.

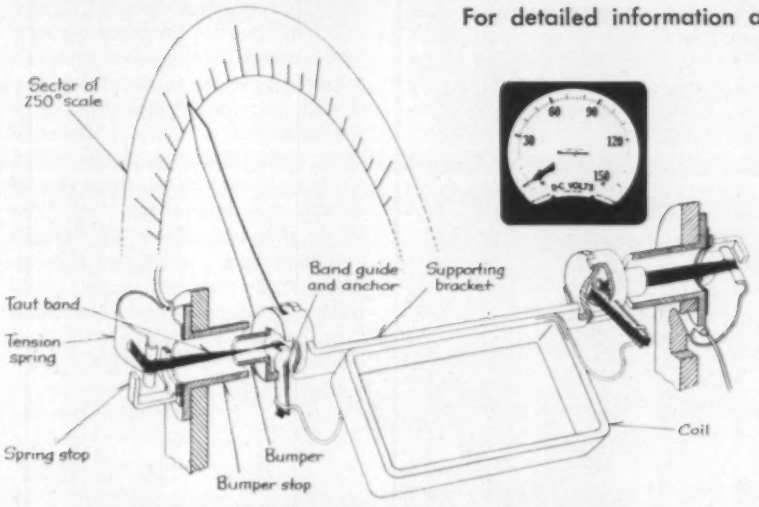


Illustration shows construction of taut band suspension system. The hairlike metal bands under tension support the moving element, carry current to the coil, and supply restoring torque.

Taut Band Suspension Instruments

SHOCK and vibration problems encountered in industry led to the development of a taut band suspension system for electrical measuring instruments. Designed by **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa., the units can withstand severe vibration and shock without the accuracy of the instrument being affected. The only frictional loss is an infinitesimal amount of molecular friction within the taut metal bands. Instruments constructed with this system include dc ammeters, milliammeters, microammeters, voltmeters, millivolt meters, frequency meters with transducers, and rectifier type ac voltmeters.

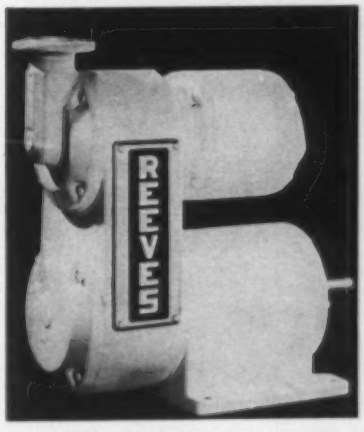
The taut band suspension system uses no pivots or bearings, is free of rolling or sliding friction. The moving element in the instrument is supported at each end by a short hairlike band of high-strength alloy, drawn to rectangular cross section. Bands measure 0.005000 inch in width and 0.000500 inch in thickness. They are dimensionally controlled to less than five millionths of an inch. They are anchored to the moving element and to U-shaped springs which maintain proper band tension and reduce shock and vibration. Small stops prevent excessive axial and radial movement. The taut bands also provide restoring torque and carry current to the moving coil. A magnetic circuit is incorporated in the instrument which makes it nearly impervious to stray magnetic fields.

Circle 428 on Page 133

Variable-Speed Drive

Item 429

Unit is applicable in the dairy, bakery processing, canning and preserving, and chemical and pharmaceutical industries where extreme cleanliness is required. Drive is finished in white enamel for easy cleaning. Other sanitary features include: Sealed inspection plates, a flat mounting pad to eliminate dirt under the drive unit, a built-in speed indicator sealed against moisture and dirt, and special seals to prevent dirt and moisture from collecting around the shaft or entering the drive housing through the shaft openings. Motor end bells are also designed to meet sanitary codes. Drive is available in sizes from ¼ through 10 hp. It



is furnished with speed ranges of up to 10:1 variation, with or without single, double, or triple-reduction, built-in gear reducers (depending on the output speeds required). **Reeves Pulley Co., Div., Reliance Electric & Engineering Co.**, 1225 Seventh St., Columbus, Ind.

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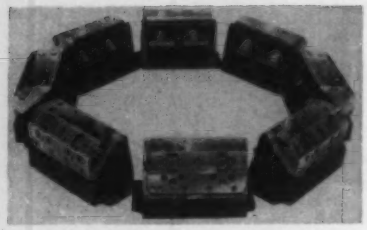


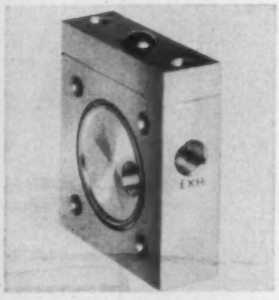
Dual Holding Fixtures

Item 430

Dual chucking, cylinder-operated holding fixtures can be used individually or mounted in groups on a rotating work table to provide simultaneous chucking of two identical parts. The clamping jaws are set at a 45 degree angle to permit both horizontal and vertical machining of the workpiece without rechucking. The chucking fixtures are hydraulically actuated, require 200 psi working pressure. Maximum jaw travel is 5/16-inch. Built-in chip covers keep jaw ways free of chips.

In operation, each set of master jaws on the dual unit is operated by a double acting integrally mounted cylinder through a cam and lever mechanism. In the gripping position, a wedge action created by angular cam surfaces is transmitted to the master jaws through a pair of forged alloy steel levers. **S-P Mfg. Corp.**, 30201 Aurora Rd., Solon, Ohio.

Circle 430 on Page 133



Ball Actuated Valve

Item 431

Designed for air, oil, or water service, ball actuated spring return valve is available with pressures to 125 psi and temperatures to 150 F. Unit features flexibility of mounting as the ball actuator can be depressed from any peripheral point of 360 degrees as long as the valve plunger is given its full 1/8-inch travel. Overtravel of 1/32 inch is provided. The valve housing is milled from solid aluminum bar stock. The valve chambers are formed with metal spacers held rigidly in metal to metal end abutment. The spacers support and position the O-ring seals.

The valve can be manifolded with others without special parts. Line air passes through each valve, across the sealed counterbore and on to the next valve, permitting eight valves to be operated simultaneously from a single supply, or up to sixteen valves simultaneously from two supply lines. **Hunt Valve Co.**, Salem, Ohio.

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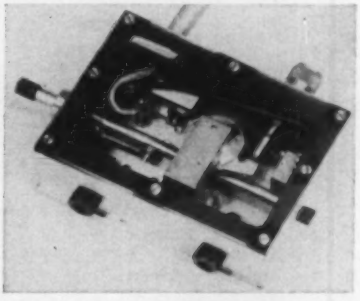

Eccentricity Indicator

Item 432

Spindle actuated, precision switching mechanism, Model A-93, is adaptable for automatic gaging operations to indicate eccentricity, runout, lack of squareness, or wobble. The variations in the workpiece condition are indicated by signal lights. Movement of the spindle in an upward direction rocks the switching lever until contact is made with the upper, adjustable stop. This action lights one of the two signal lights normally used. When the piece is rotated, the spindle moves down again. If the switching lever is rocked enough to make contact with the lower, fixed stop, there is too much eccentricity and the piece is rejected. A spring clutch on the switching lever permits the spindle to continue moving in either direction after the switching lever hits either (adjustable or fixed) stop. **Federal Products Corp.**, Providence, R. I.

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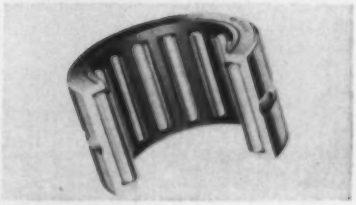

Caged Needle Bearing

Item 433

Unit is dimensionally interchangable with heavy duty needle bearings, will provide adequate capacity where excess misalignment prohibits using the greater inherent capacity of full complement bearings. It is available with or without separable inner races. A one-piece, channeled outer race contains a single row of rollers in a continuous steel cage. Outer ring and rollers are through hardened and precision ground. Black oxide finished cages guide rollers at the pitch line. Bearing is furnished in six standard stock sizes. **Bearing Div., McGill Mfg. Co. Inc.**, Valparaiso, Ind.

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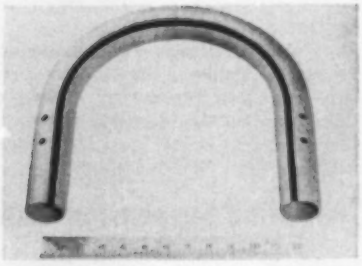


Conveyor Curves

Item 434

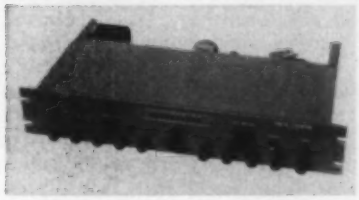
Horizontal curves with 6, 9, or 12-inch radius are designed for company's overhead conveyor system. They are suitable for use in ovens, drying areas, and storage lines. Numerous combinations of turns can be made by joining horizontal and vertical curves. Wherever parts clearance permits, the system can be used to conserve oven space and reduce size requirements of processing equipment. Curves are constructed from high grade alloy steel, hardened throughout, and fabricated to exacting specifications. **Chainveyor Corp.**, 5618 E. Washington Blvd., Los Angeles, Calif.

Circle 434 on Page 133

Pulse Counter

Item 435

Variable scale counter contains a beam switching tube (a decimal counting device) which enables the unit to count and reset to fre-



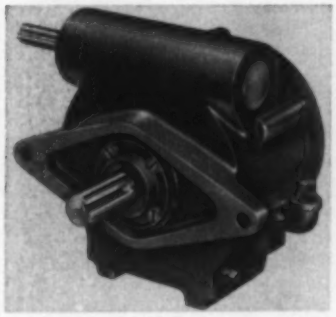
quencies of one megacycle. Two types of outputs are available: A 0.1 microsecond pulse of variable amplitude which makes the unit compatible with other instruments such as pulse generators, and delays; and as many as 10 dc levels are available to directly drive a sequence gater. Reset time for Model 1751 is less than one microsecond. **Electronic Tube Div., Burroughs Corp.**, Plainfield, N. J.

Circle 435 on Page 133

Gear Transmission

Item 436

Unit is rated at 225 ft-lb at 8 rpm output. Model DS has a 220:1 ratio, and incorporates a counterclockwise input and output. The worm is of high carbon alloy steel. The worm gear is constructed in two pieces, and the gear portion is of a bronze alloy. The sun gear is cut from an alloyed grey iron cast-



ing containing chromium and vanadium. The ring gear is cut integral with the grey iron housing. The most suitable lubricant to be used is one containing lead naphthanate and sulphurized sperm oil. **Merkle-Korff Gear Co.**, 213 N. Morgan St., Chicago 7, Ill.

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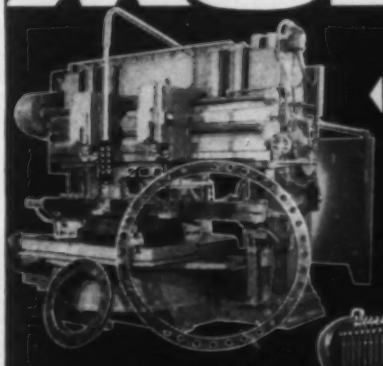
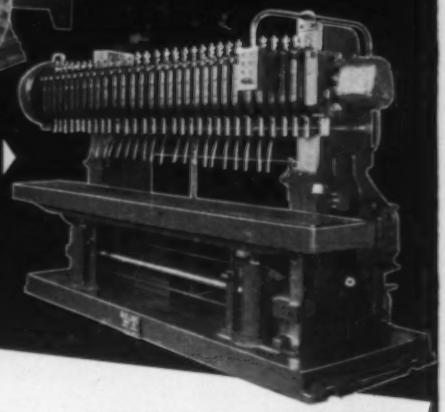
MOLINE



HD68 drills bolt circles from 12" to 100" diameter. Each of the two spindles has capacity for 2¼" drill in steel. Operating cycle is fully automatic.



HD13 straight line-type drilling machine with capacity for thirty ¾" drills in steel. Used for work on heavy castings, round and rectangular steel tubes, structural shapes, plates and grader blade drilling or countersinking.

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PRODUCTION . . . EFFICIENCY . . . SAVINGS

Use an individually designed "Hole-Hog" Machine Tool for such jobs as...

- Multi-Spindle Boring
- Single and Multi-Spindle Honing
- Straight Line Multi-Drilling
- Adjustable Spindle Drilling
- Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
- Transfer-Type and Special Machines

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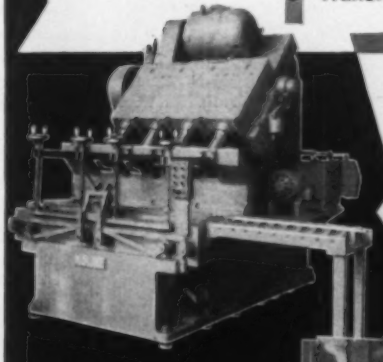
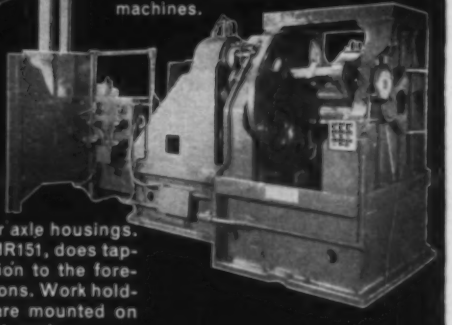


13CB hydraulic feed cylinder boring machine. V-8 engine blocks are rough and finish bored for wet-type cylinder sleeves. Units of this kind are applicable for transfer machines.



MR152 performs drilling, reaming, spot facing and chamfering operations on tractor rear axle housings. A companion machine, MR151, does tapping in addition to the foregoing operations. Work holding fixtures are mounted on power driven trunnion.

MOLINE TOOL CO. MOLINE, ILLINOIS

MOLINE TOOL COMPANY

REPRESENTATIVES IN PRINCIPAL CITIES

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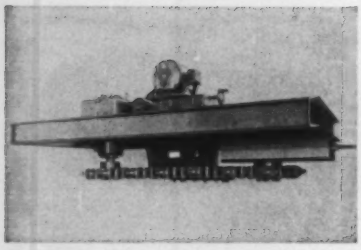
Circle 689 on Page 133

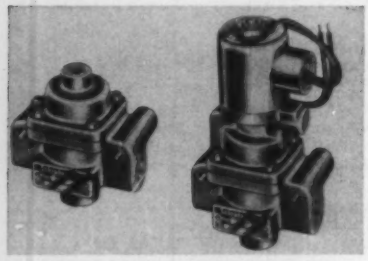


Conveyor Drive

Item 437

Variable speed caterpillar drive is designed for company's overhead trolley conveyors. The drive sprocket is mounted directly on the slow speed shaft of the vertical-type reducer, eliminating the need for the spur gear and pinion. For installations where multiple drives are required, floating drives can be furnished. Fluid drives are furnished for high inertia loads, as well as automatic overload cut-offs. **Alvey-Ferguson Co.**, 2811 Disney St., Cincinnati 9, Ohio.

Circle 437 on Page 133



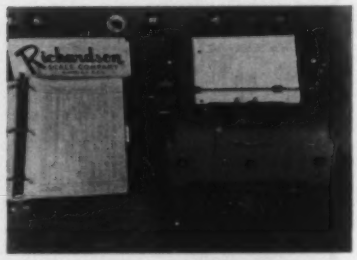
Interchangeable Valves

Item 438

Three-way solenoid valve and three-way pilot valve have the same type base and operating parts, can be interchanged. The pilot valve can be converted to a solenoid type by replacing the pilot chamber with the solenoid head and vice versa. By shifting the pilot or solenoid chamber head 90 degrees, the valve can be changed from a normally open type to a normally closed type valve. The pilot valve has one moving part and the solenoid has three moving parts. They are available in air pressures ranging from 20 psi to 150 psi. Voltages are 12, 110, 220, and 440 v.

The valves can be mounted through side bases. The poppet-type design of both valves permits maximum air passage with air moving freely for less pressure drop. Other features are: Clearly marked inlet and outlet ports, oil-resistant synthetic rubber washers, and stainless steel springs. Operating life of the valve is said to be 10,000,000 continuous cycles. **A. Schrader's Son, Div., Scovill Mfg. Co.**, 470 Vanderbilt Ave., Brooklyn, N. Y.

Circle 438 on Page 133

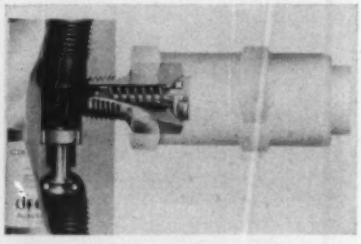


Typewriter Readout

Item 439

Device provides a typewritten record of weights of individual ingredients, batch weights, and other data such as time, date, and batch number. The typewriter keys are solenoid operated; maximum typing speed is 11 characters per second. An interlock switch regulates typing sequence and speed. A column verifier is attached to the typewriter carriage and operates through a checking circuit to insure that the data being typed are recorded in the correct columns. An indexing circuit is arranged so that if the typewriter carriage is out of sequence with the input circuit, the printing cycle will stop. The carriage must be properly aligned under the correct columns in order to continue operation. **Richardson Scale Co.**, Van Houten Ave., Clifton, N. J.

Circle 439 on Page 133



Gage Protector

Item 440

Device for actuation from 5 to 2400 psi features an instant and precise shutoff to protect gages from over-pressure. The protector is designed for gas systems, but is also available for liquid systems. In operation, where surge waves or shock waves are encountered, a snubbing action closes the valve unit momentarily to reduce shock on gage elements. In the event of bourdon tube rupture, the protectors automatically shut off the unit instantly. The system permits cascading gages to provide accurate presure readings over a wide range of pressure. Gage protector valves automatically cut out lower pressure gages as the system pressure rises and cut them in as the system pressure falls. **Circle Seal Products Co. Inc.**, 2181 E. Foothill Blvd., Pasadena, Calif.

Circle 440 on Page 133

Welder Control

Item 441

Unit designed for company's resistance welders, is composed of three basic parts: The timing panels, the firing panel, and the ignitron contactor panel. Transistors and printed circuits are used in the timing and firing panels. The control unit is used to time and sequence a number of successive functions in resistance welder operations. All control functions use the same timing circuit (this includes a switching circuit which steps from one function to the next to control the sequence of operation). A dual weld timer permits immediate changeover from one weld time to another. The switching circuit also performs the change in timing adjustment for each successive function. The sequence functions of *Squeeze*, *Hold*, and *Off Time* are controlled by precision potentiometers. Model SWC-2X is

rated for 230 v or 460 v. **Sciaky Bros. Inc.**, 4915 W. 67th St., Chicago, Ill.

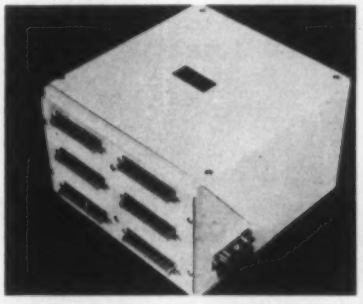
Circle 441 on Page 133

Lubricator Alarm

Item 442

Suitable for use on company's force-feed lubricators, shaft rotation alarm is designed to shut down the compressor if the lubricator stops rotating or the oil level drops in the reservoir. Unit includes a small pump, a bleed down chamber, and a pressure switch which is actuated by the pressure in the bleed down chamber. As long as pressure is maintained, an uninterrupted signal is furnished by the pressure switch. If the pump should not receive oil, or the camshaft stops rotating, the signal is interrupted and the compressor shuts down. **Manzel, Div., Houdaille Industries Inc.**, 315 Babcock St., Buffalo 11, N. Y.

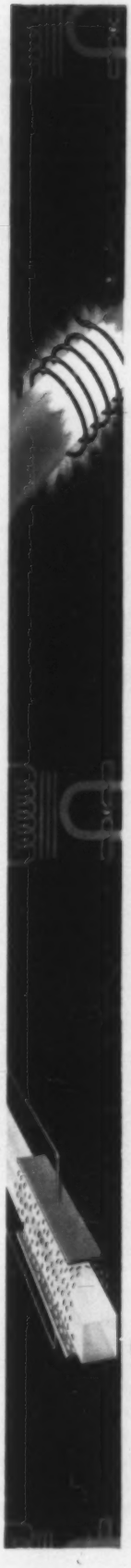
Circle 442 on Page 133



Sampling Switch

Item 443

Suitable in the instrumentation fields, multichannel sampling switch is designed for sequential drift stabilization of up to 83 high gain dc amplifiers. Model 108A has two poles, 170 contacts per pole, or 85



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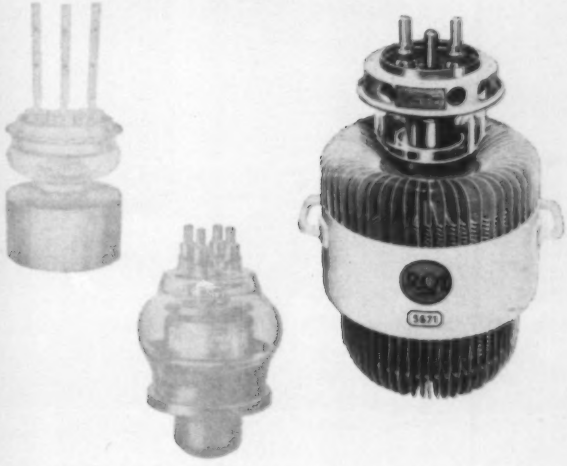

For high-efficiency electronic heating and other industrial applications involving high radio-frequency power, RCA offers an established group of Power Tubes. They are conservatively designed for long life and thus provide low tube cost per hour of operation.

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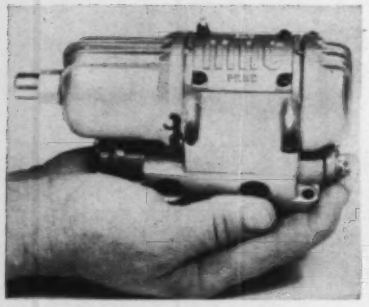
nonshorting channels per pole. A removable cover permits inspection while in operation. Switch is supplied with a 110 v, 60 cps, single phase, synchronous motor which drives the rotor at approximately 3 rps. **General Devices Inc.**, Box 253, Princeton, N. J.

Circle 443 on Page 133

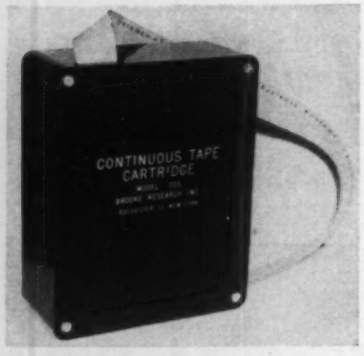


Dual-Seal Valve

Item 444

Four-way dual-seal valve is available in 1/4, 3/8, and 1/2-inch port sizes. Unit consists of 11 parts (3 moving parts), will not operate with the cover removed. A feature of the valve is add-a-unit interchangeable manifold bases which permit the grouping of from 2 to 10 valves. When combined, the bases form a single inlet, single exhaust, and single conduit channel. **Mechanical Air Controls Inc.**, 10030 Capital, Oak Park, Detroit 37, Mich.

Circle 444 on Page 133

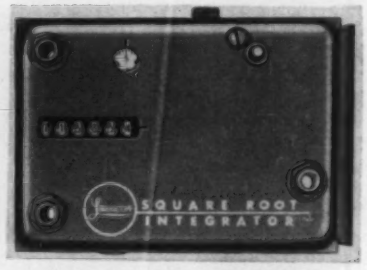


Tape Cartridge

Item 445

Self-contained unit (Model 203) permits continuous loops of punched-paper or plastic tape to be fed to and from punched paper tape readers and punches. It is applicable on automatic testing machines, tape programmed machine tools, digital computers, and tape-programmed electric typewriters. Power for the tape motion is taken from the tape reader. The cartridge is attached to the tape reader panel by two slide fasteners. Rewinding tape at the end of a program is eliminated as the tape can be spliced at the ends to form a continuous loop. **Brooks Research Inc.**, P. O. Box 67, Rochester 10, N. Y.

Circle 445 on Page 133



Square-Root Integrator

Item 446

Device provides a continuous means of automatically totaling flow, is designed for use in flowmeters that utilize the output of conventional sensing elements. It can also be adapted to miniature strip chart flow recorders, forming an electromechanical integrator. Model 26 uses a double disc and ball integrating mechanism to measure flow. With a given speed on the lower disc, the upper disc and counter turn at a speed proportional to the square root of the displacement of the balls from the center of the disc.

Linearity of the integrator is 0.25 per cent of full scale; repeatability is 0.05 per cent of full scale. An input speed of 60 rpm, combined with a full scale ratio between the time shaft and the counter of 2:1 provides the counter with a maximum rate of 300 counts per minute. Unit has an input shaft torque of 0.35 in-oz maximum and a shaft rotation of 18 degrees 30 minutes. Maximum time shaft torque is 0.5 in-oz. Operating temperature range is − 40 to + 150 F. **Commercial Div., Librascope Inc.**, 40 E. Verdugo Ave., Burbank, Calif.

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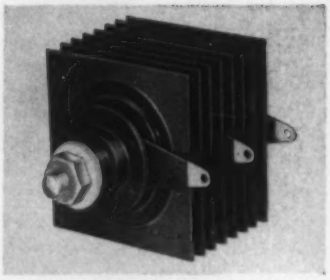

Selenium Rectifier

Item 447

Unit features a grain oriented construction, which is a polycrystalline selenium layer with grains oriented in parallel fashion rather than a disoriented pattern. This design is said to increase the current ratings without increase in cell size. Rectifier is available in cell ratings of 18 to 36 v. **Electric Products Div., Vickers Inc.**, 1815 Locust St., St. Louis, Mo.

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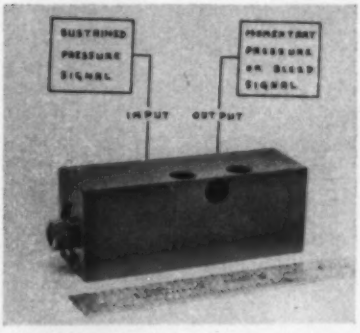

Air Signal Converter

Item 448

Model V125A is a pneumatic control component designed to provide an adjustable short duration pressure or bleed output signal from a sustained pressure input signal. It is suitable for use on machine tools, packaging machines, or feeding devices to operate balanced type three of four-way air valves, or it can provide controlled time loading of air cylinders to perform actions such as ejecting, transferring, escaping, or pressing. Duration of the output signal is adjustable from zero to 10 seconds when operated from an 80 psi source. Cycle rates up to 100 cycles per minute can be obtained. Unit operates on input air pressures from 40 to 150 psi and controls output pressures up to

150 psi. Orifice area controlling the output signal is 0.0138 sq in. **Hause Machines Inc.**, Montpelier, Ohio.

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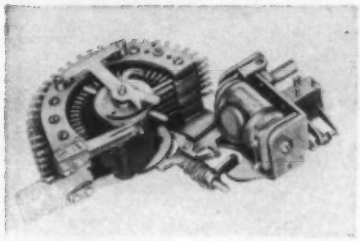

Spark Suppressor

Item 449

Silicon-carbide varistor is designed for use on company's rotary stepping switches and relays which operate on 24, 48, or 110 v dc. The suppressor, which is small in size, is coated with an insulating film in three colors for easy identity.

Because of its size, it can be mounted and wired directly to the terminals of the coil. The space-saving varistor is said to suppress arcs effectively and reduce radio interference. Loose varistors, provided with two, 2-inch leads of tinned copper wire (22 ga) are available for replacing capacitor-resistor spark suppressors on Types 44 and 45 stepping switches, and Series OCS relays. **Automatic Electric Co.**, Northlake, Ill.

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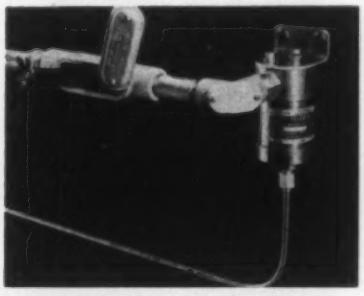

Pressure Transmitter

Item 450

Device features a high frequency response for measuring dynamic pressures encountered in turbine power plants, hydraulic systems, and high speed chemical reactions. It can be used with servo indicators, recorders, and controllers to measure liquid or gaseous pressures. Most gases as well as corrosive media can be handled. Transmitter uses a proving ring principle with 4-arm bonded strain gage bridge. The pressure cavity has a low volume which results in a fast response to dynamic pressures and is sealed off from the electrical measuring element by multiple diaphragms which provide a positive vaporproof seal. The gasproof electrical connection consists of a taper-threaded pipe connection. A length of four-conductor cable is sealed inside the threaded connection with a high quality potting compound to provide a positive seal against gas or vapor leaking into the sensing element chamber. Linearity of the unit is 0.25 per cent, hysteresis 0.5 per cent, ambient temperature from −65 to 250 F, pressure ranges are from 300 to 10,000 psig. **Taber Instrument Corp.**, 107 Goundry St., North Tonawanda, N. Y.

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Digital Voltmeter

Item 451

Applicable in data handling systems, self-contained unit can provide an accurate digital readout of analog voltages. Four-digit numerals are visible at distances up to 50 feet with up to 70 degrees of access in all directions. Three range scales are provided—from zero to 10, 10 to 100, and 100 to 1000. Accuracy is 0.01 per cent of full scale on all three ranges. Both positive and negative inputs can be read by the voltmeter and the input sign is automatically displayed on the front panel. Model 26.044 provides automatic adjustment of range by means of internal circuits. Speed of the instrument is an average of 5 millisecond per reading. Where there is a change of

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Eriez Mfg. Co., 119M Magnet Dr., Erie, Pa.

ERIEZ

Circle 690 on Page 133

polarity or range, an additional 3 to 9 millisecond is required before a correct reading can be displayed. **Electronic Associates Inc.**, Long Branch, N. J.

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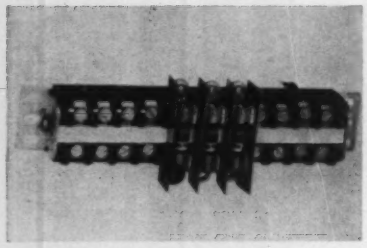

Terminal Fuse Block

Item 452

Designed for electronic and control applications, unit is applicable wherever several fuses are required. An assembly kit contains fuse clips and insulating barriers which can be snapped on the terminal block and can be installed in the field without special tools or fasteners. The kit can accommodate both glass and indicating type 110 v fuses. Any number of fuse blocks can be grouped together on one strip. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

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Load Regulator

Item 453

Device measures and controls current to ac motors and circuits, is applicable on motor driven compressors, exhausters, blowers, pulverizers, and other instruments which have motor drives ranging from 5 to 10,000 hp. When used as a controller, the set point can be remotely established by automatic pneumatic adjustment. Any variation in the set point causes the motor load regulator to increase or decrease the process load on the motor, thereby re-establishing the balance between current and desired set point. In an application such as this, the cam in the set point mechanism can be shaped and sized to match specific process characteristics.

When the device is used for current measurement, the pneumatic output is a zero to 30 psi signal. A change in line current is sensed by the instrument coil which causes a magnetic core to move up or down and decrease or increase the output pressure signal. The output signal is then fed back through the cam head which balances the core movement, yielding a control signal linear with respect to current. Instrument is rated for 5 amp; accuracy is ±0.1 amp and repeatability is better than 0.05 amp. **Hagan Chemicals & Controls Inc.**, P.O. Box 1346, Pittsburgh 30, Pa.

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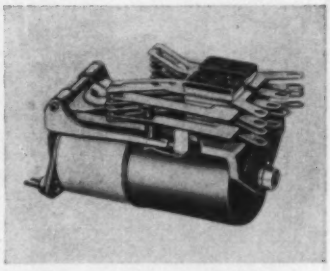

Time Delay Relay

Item 454

Unit, designated Class 66S, features a long service life due to a heavy heel piece to stabilize contact adjustments, a pin-type armature hinge with stainless steel pin and precision reamed oversize bearing surfaced in a heavy duty yoke, and wear resisting buffers which are attached to contact springs. The design of the coil space makes it possible to use long slugs for *Operate* delay up to 0.15 second and *Release* delay up to 0.25 second. Relay is available with numerous contact combinations in a range of contacts from bifurcated gold alloy for dry circuits to 10 amp heavy duty contacts for power switching. For dc operation only, it is available for standard voltages to 230 v dc. **Magnecraft Electric Co.**, 3354D W. Grand Ave., Chicago 51, Ill.

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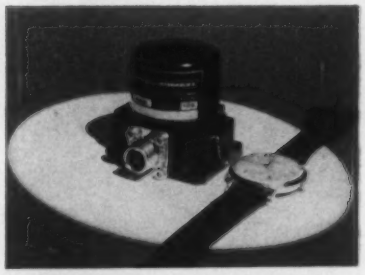

Miniature Servo Valve

Item 455

Miniature valve is constructed with only two moving parts (4-way spool and torque motor armature), uses oversize orifices which permit operation with contaminated fluids. Compensation for pressure and temperature variation is made by the use of unity hydraulic feedback. Inherent unity feedback of the spool position also reduces sensitivity to load, pressure, and vibration. Flow rates range from zero to 2, zero to 5, and zero to 10 gpm at a supply pressure of 3000 psi; supply pressures range from 500 to 3000 psi. The 4-way spool is free floating, has an inherent dither which acts directly on it. **Kearfott Co. Inc.**, 1378 Main Ave., Clifton, N. J.

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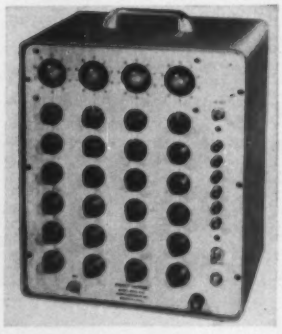

Preset Counter

Item 456

Instrument can be supplied with multiple groups of presetting controls for use in operations which require high speed sequential predetermined counting and control. A complete program can be preset for any operation that requires a machine controlled at different predetermined counts. Counting speeds are up to 30,000 per minute. Model 2020 can be supplied with various inputs, including photocells, me-

chanical contacts, or pulses. **Freed Transformer Co. Inc.**, 1705 Weirfield St., Brooklyn 27, N. Y.

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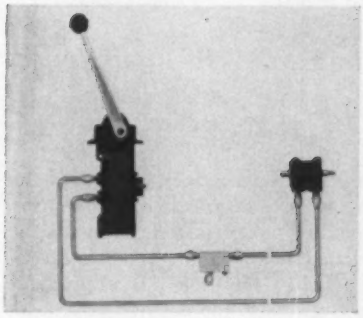

Remote Control Unit

Item 457

Straight-line, hydraulic remote control unit can be mounted in any position and connected to throttles, valves, equalizers, and clutches. The piston and master control lever are synchronized at all times. System is designed with an integral filler-bleeder fitting which eliminates the need for accessory pressure equipment. When filling and bleeding have been completed, an adjustment of the equalizer valves permits the positioning of the master lever and piston. The master unit automatically compensates for expansion and contraction of fluid due to temperature variations. **Hydronic Co.**, 12685 Arnold Ave., Detroit 39, Mich.

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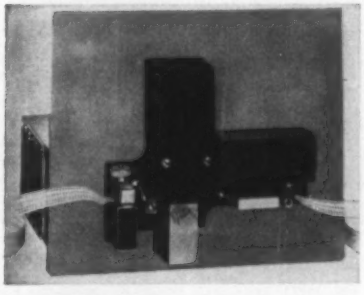

Tape Strip Reader

Item 458

Transistorized perforated tape strip reader is capable of speeds up to 1000 characters per second. It can process information on perforated tape strips into digital data computer systems. Model 909

NEW **REEVES**®

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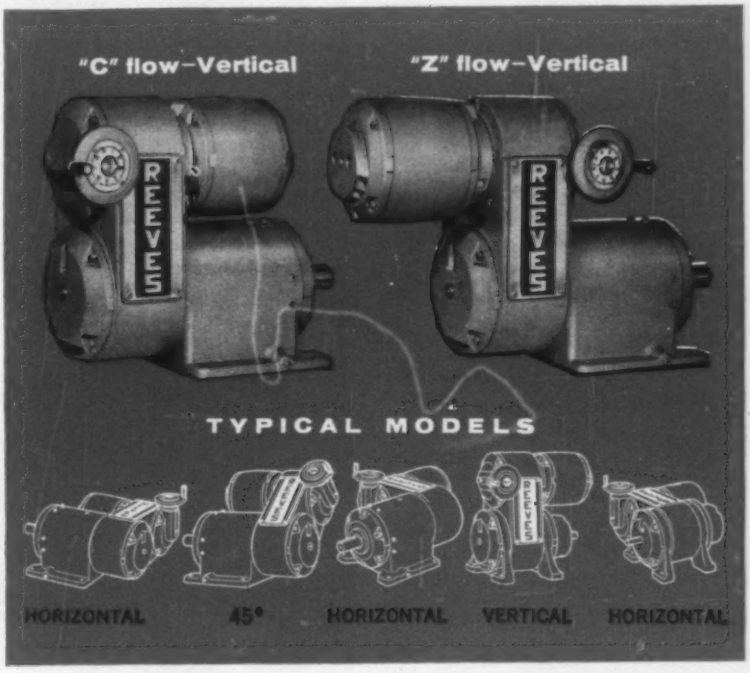
**200-300-400 Sizes, 1 through 10 hp.; full line, ¼ through 40 hp.*



The flexible design of these compact new REEVES variable speed power packages permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements. All models are available in both "C" flow and "Z" flow styles.

New increased capacity is built in the reducers—single, double or triple stages . . . new disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

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REEVES PULLEY COMPANY

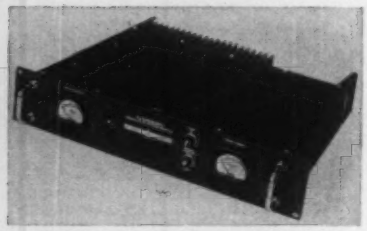
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 691 on Page 133

can read up to 8 level tape with sprocket channel. *Start* and *Stop* time is 3 milliseconds or less. Approximate life of the reader is 10,000 hours. It will operate in ambient temperatures up to 125 F and is not affected by temperature changes. **Potter Instrument Co.**, Sunnyside Blvd., Plainview, N. Y.

Circle 458 on Page 133



Power Supply

Item 459

Regulated power supply is designed with transistors, features convection cooling. It can operate at maximum rating of 50 C ambient temperature without internal blowers or other moving parts. Model LT 2095M (shown) has a range of 0 to 32 v dc, 0 to 2 amp. Input rating is 105-125 v dc at 50-400 cycles.

Power supply has silicon rectifiers, radiator heat sinks, a hermetically sealed transformer, and a remote sensing and dc vernier. It also features an ambient thermal protection, fast transient response, low output impedance, and low ripple. **Lambda Electronics Corp.**, College Point 56, N. Y.

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Transistorized Counter

Item 460

Instrument is applicable in measuring and control functions, processing and packaging operations. It can also be adapted to operate printed readout devices. The preset range is from zero to above 180,000 counts per minute with instantaneous reset. Totalizing speed is from zero to 300,000 counts per minute. For counting two quantities, alternate and dual presets are available.

Counter is composed of transistors, direct-reading glow-decade counter tubes, and wetted mercury contact type relays. All components are mounted on replaceable etched circuit plug-in boards. Direct readout is provided through the use of in-line neon tubes. These tubes display illuminated numbers on separate tube faces, are readable from 50 feet away. **Dynapar Corp.**, 5150 Church St., Skokie, Ill.

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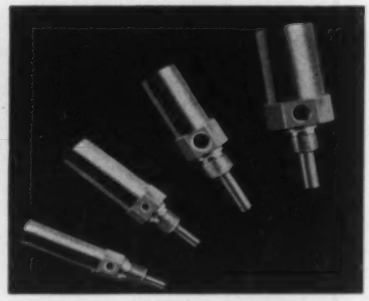


Miniature Air Cylinders

Item 461

Line of miniature air cylinders is applicable in feeding, ejecting, soldering, welding, brazing, stamping, bending, marking, and assembly operations. Bore sizes of the cylinders are $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, and $1\frac{1}{2}$-inch. Units are constructed with a brass tube wall $\frac{1}{8}$-inch thick. The blind ends are silver-brazed to the tube, and the front gland piston rod end is internally threaded. **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9. Ohio.

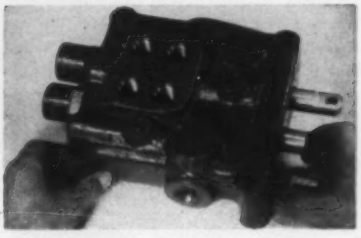
Circle 461 on Page 133

Overload Control

Item 462

Relay is designed to stop an overloaded electrical motor during the critical peak or starting load period. It is said to respond instantly to all momentary overloads and is applicable on almost all types of motorized applications. Action of the relay is controlled by a limiting pointer which is reset close to the actual normal electrical power required by the drive. It will not interfere with the conventional indicating pointer's movements across the dial face of the relay. A setting button, (protected by a guard to prevent tampering) makes it possible to set the current-controlling pointer at any current value desired. **Baker Perkins Inc.**, 1000 Hess, Saginaw, Mich.

Circle 462 on Page 133



Directional Valve

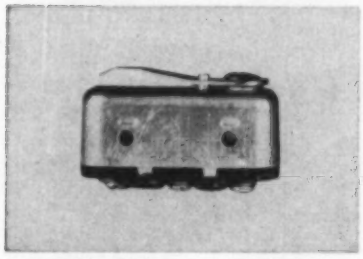
Item 463

Line of hyraulic directional control valves is suitable on material handling and industrial equipment. Nominal ratings are from 5 to 25 gpm, with up to 6-spool configuration. The valve is designed with an open-center parallel-circuit design which permits independent or simultaneous operation of cylinders or hydraulic motors. Actuation of the valve is through a lever control. Operating pressure is up to 2000 psi.

Double-acting, single-acting, and float type spools of hardened ground steel provide for precise load positioning, holding, raising or lowering operations, and for accurate control of hydraulic motor operation. A double-acting motoring spool is used with hydraulic oil motors. When the spool is in the

Neutral position, the motor ports are connected to the tank, permitting the motor to run free. Inlet and outlet ports are located on either side of the valve body opposite each other. **Wooster Div., Borg-Warner Corp.**, Bedford, Ohio.

Circle 463 on Page 133

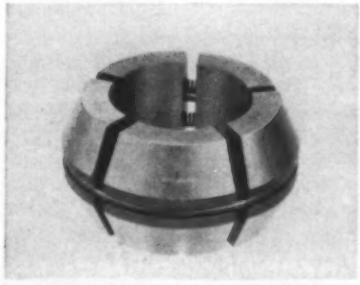


Snap Action Switch

Item 464

Hermetically sealed, snap-action, precision switch, designated Model SBS-100A, is suitable for control applications. Unit weighs approximately 1-1/3 ounces, maintains a high contact (75 grams) pressure. Life of the unit is said to exceed two million operations. Additional features of the switch include: ample overtravel with positive stop, positive snap-action with no dead center, and it is unaffected by salt water, salt air, sand, or dust. **Sealectric Switch & Relay Corp.**, 6025 N. Keystone Ave., Chicago 30, Ill.

Circle 464 on Page 133



Cast Iron Collet

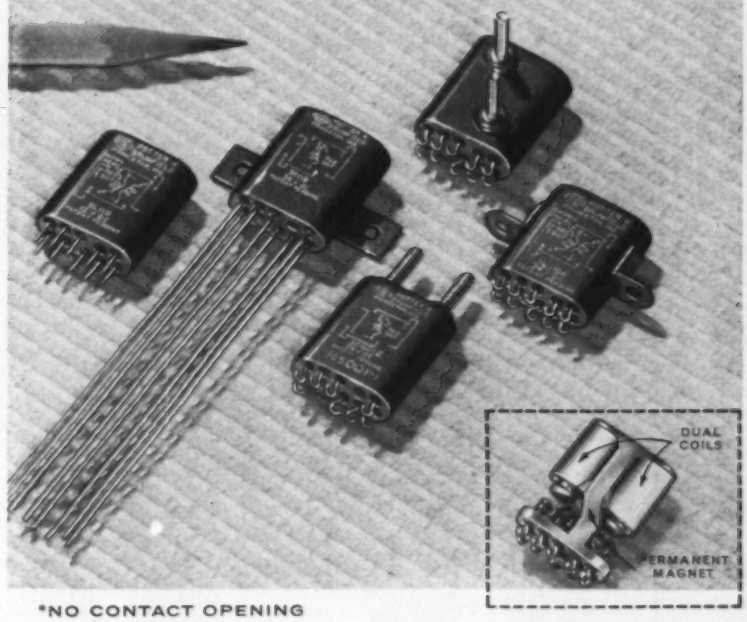
Item 465

Designed for automatic cut-off machines, collet is divided into 5 moving segments for positive gripping of stock that may be slightly out of round. It also reduces scratches and mars on stock being cut. When polished stock is cut off, a cast iron bushing fits into an inner

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

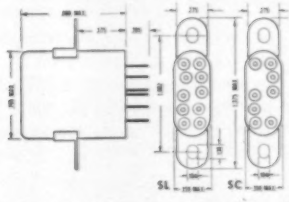
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 230 mw, 3 ms. pulse at 25° C. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 260 mw at 25° C. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g. for 11 ms.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC.)
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.
CONTACTS:
Arrangement: 2 Form C.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.
COIL:
Power: SL—230 mw @ 25° C.
SC—260 mw @ 25° C.
Resistance: SL—10,000 ohms per coil max.
SC—20,000 ohms max.
Duty: Continuous.
MOUNTINGS:
Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

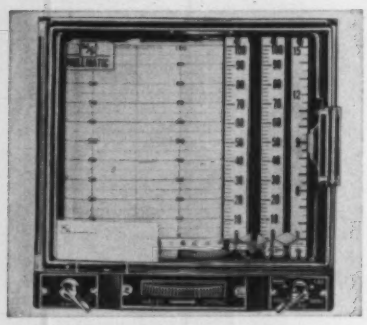
POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

Circle 692 on Page 133

tube so the stock never touches the collet. For some cases, a cast iron inner sleeve is used at the rear of the guide bushing to prevent scratches. **Modern Machine Tool Co.**, 2005 Losey St., Jackson, Mich.

Circle 465 on Page 133



Cascade Controller

Item 466

Control station is available in two styles—an indicating model and a recording model (shown). It can perform all the operations required for a cascade system. The switching sequence is foolproof. The operator need only use one knob to transfer between any two control positions. Unit uses O-ring-and-plunger-type switches. The recording models have 31 day charts with scales for flow, temperature, pressure, and other process variables. **Moore Products Co.**, H & Lycoming Streets, Philadelphia 24, Pa.

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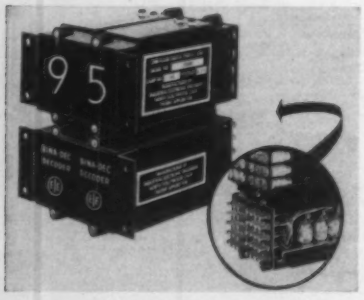
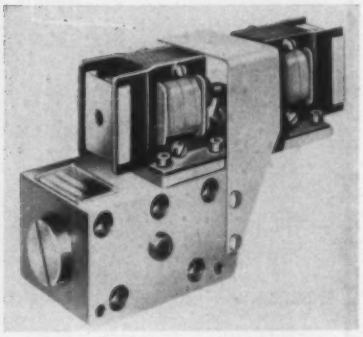


Relay Decoder

Item 467

Suitable for use with electronic equipment such as digital display units, instrument is designed to translate coded information into decimal form. It can be used in any circuit requiring a binary-to-decimal conversion. Decoder uses a relay tree to perform the translation, the number of relays depending on the code used. Four or five terminals plus a common terminal are provided for input information to control the relays, and ten terminals plus a common terminal are provided for the outgoing decimal information. For pulse type operation, lockup contacts are available to maintain settings. **Industrial Electronic Engineers**, 3973 Lankershim Blvd., North Hollywood, Calif.

Circle 467 on Page 133



Directional Control Valve

Item 468

Four-way, two-position, detented, dual solenoid operated valve can be used to remotely control the direction of flow for hydraulic actuations. The 1/4-inch unit has a close grain electric furnace iron body with hard nitraloy stem, ground and lapped to fit. Flow capacity is 3½ gpm, operating pressure 1000 psi. It can be mounted horizontally or vertically and is available in manifold or pipe tap styles. **John S. Barnes Corp.**, Dept. AUT, 301 S. Water St., Rockford, Ill.

Circle 468 on Page 133

Shaft Turns Counter

Item 469

Applicable on multiturn potentiometers and variable capacitors, unit provides precision setting, adjustment, and relocation of rotating adjustment shafts. The knob on the turns counter assembly mounts on the component adjusting shaft and operates both the shaft and the turns counter. Each one-hundredth clockwise revolution adds one full unit count on the counter

and each one-hundredth counter clockwise revolution subtracts one full unit count. The counter continuously gives direct digital reading of the shaft position in hundredths of turns. It provides direct readings to 999 or ten complete clockwise revolutions of the shaft. Accurate readings continue after the tenth revolution but 1000 must be added to the direct readings. **Production Instruments Div., General Controls Co.**, 8078B McCormick Blvd., Skokie, Ill.

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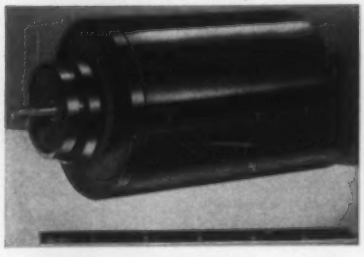


Digital Encoder

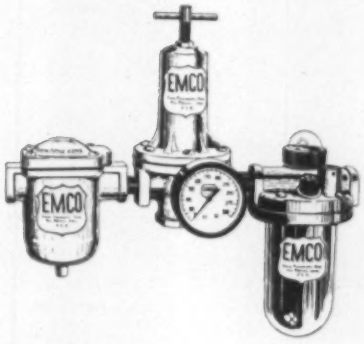
Item 470

Instrument can encode the angular position of high-speed rotating shafts, is suitable as the feedback element in digital shaft-positioning servomechanisms, to couple rotating analog devices into digital computers, and for converting two-speed analog shaft data into a single, linear, digital word for data proccessing. Model DV-13A, a 13-digit shaft-angle encoder, has a built-in alignment cell for establishing optical-mechanical concentricity precise to 110 parts per million. Accuracy of shaft-angle indication is held to better than ±2.5 minutes of arc. Readout is possible up to a maximum reading rate of 100 complete digital words per second.

Encoder employs a coded transparent disc with a cyclic (Gray) binary pattern in thirteen concen-

tric tracks. The shaft-angle code is read by means of an optical system having a radial-slit flash-lamp illumination source, a corresponding radial array of thirteen light detector cells, and thirteen associated preamplifiers. The alignment cell is mounted diametrically opposite to the 13th cell in the reading array. Unit can be operated within specifications under shocks up to 20 g's and vibrations of 55 cps with a 0.015-inch amplitude. **Dychro Corp.**, 125 Mt. Auburn St., Watertown 72, Mass.

Circle 470 on Page 133



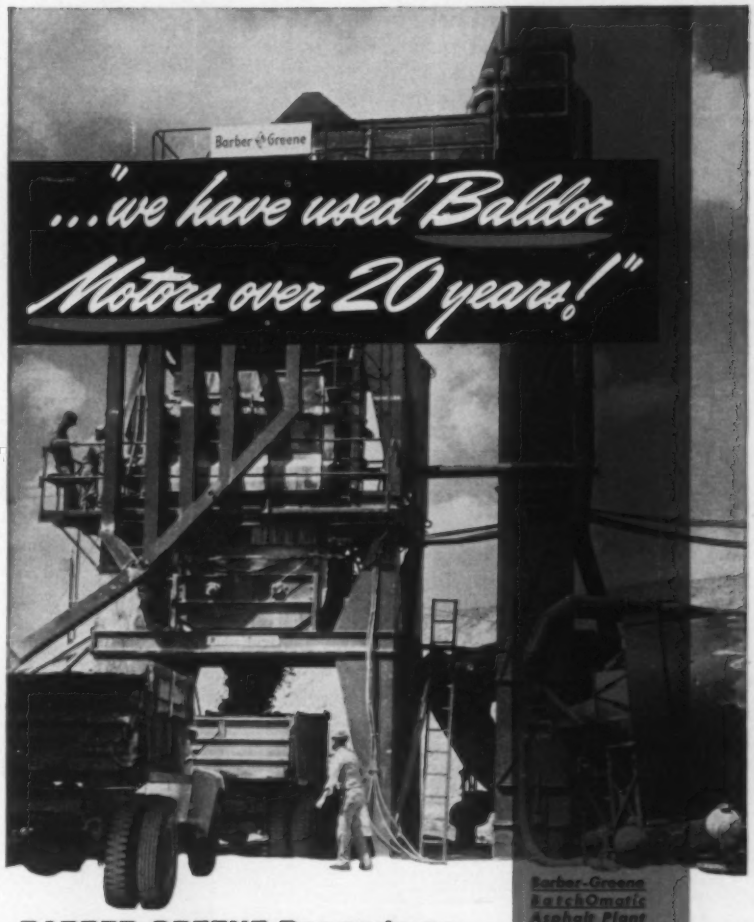
Air Control

Item 471

Combination filter, regulator, and lubricator is pneumatically operated, is capable of removing moisture, and other impurities from the air system; regulating the air to the required operating pressure; and delivering the required lubrication to the air stream. Each unit is equipped with a gage which can be installed on the right or left side. When maintenance is required, each unit can be completely disassembled while in line.

Principle of operation of the lubricator is the acceleration of air to form the oil mist as it passes through a venturi, delivering oil only when an application of air is made. A built-in oil manifold guarantees oil in the oil nozzle at all times. Oil in the regulator is easily regulated for large and small volumes of air, and a sudden surge of back pressure will not charge the oil reservoir and force the oil back into the line. The lubricator is designed so that moisture will not accumulate in the reservoir.

The automatic air filter provides filtration by two means: The heavier than air particles are separated



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Barber-Greene BatchOmatic Asphalt Plant

Up to 6 Baldor Streamcooled Motors are used to power these gigantic machines

Despite the most torturous use, plus the constant hazard of dust and dirt, Baldor Streamcooled Motors keep famous Barber-Greene equipment operating at top efficiency, day after day.

This kind of superior performance has earned Baldor an enviable reputation among many outstanding heavy equipment manufacturers.

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Circle 693 on Page 133

by the centrifugal motion set up by the air turbulence. The air is further filtered as it passes through two dutch weave monel filter screens; tested for 0-30 micron Arizona dust. Filter is diaphragm operated and actuates by a differential change of air pressure. When the air pressure on top of the diaphragm is reduced, as an application of air is made, the lower valve is lifted off seat and the condensates are ejected out the drain trap. The projection at the bottom of the filter permits the attachment of a hose or a plastic tube to carry the condensates away to a container.

The regulator has large air ports throughout, can deliver maximum air flow with minimum pressure drop. Regulated air remains as near constant as possible even with fluctuating inlet pressures. The diaphragm chamber is isolated from the flow stream for more efficient regulation of air and greater flow capacity. Pipe sizes range from ¼ to ½ inch with maximum inlet pressure of 250 psi. **Emco Pneumatic Corp.**, 1317-1319 Locust St., Des Moines, Iowa.

Circle 471 on Page 133

free catalog

47-page catalog illustrating complete line of

AIR CYLINDERS,
AIR VALVES,
AIR CLAMPS,
DIAL FEED TABLES

WRITE BEFORE NEXT TUESDAY

ALLEN AIR

The cylinder of "distinction" shown above is a Factory Reject. Only straight rods available.

THE A. K. ALLEN CO. AU-12
225 East 2nd Street, Mineola, N. Y.
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Company.....
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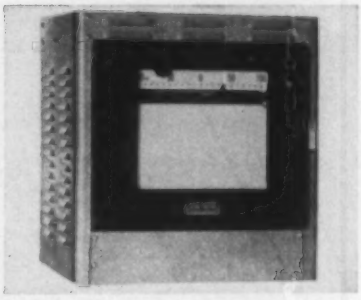
City.....Zone.....State.....

Circle 694 on Page 133



Segmental Recorder

Item 472

Instrument provides immediate visual results to supplement non-indicating scanning systems. It is also adaptable for collecting and plotting data in applications without scanning systems. Model 156 is a multichannel plotter with a separate graph for data from each source input. Each graph plots the measured variable as a function of time. Up to 192 different channels can be plotted, giving 192 separate graphs. Recorder can be mounted on a rack, table, console, or portable cart. It is also available as a 24, 32, 48, or 96 channel instrument. **Gilmore Industries Inc.**, 13015 Woodland Ave., Cleveland 20, Ohio.

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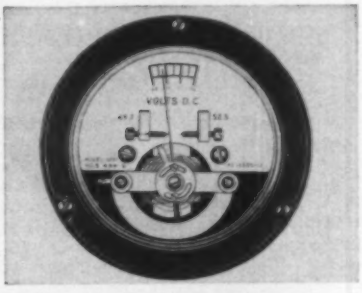

Instrument-Type Relay

Item 473

Unit has nonlocking, nonmagnetic contacts, features a core magnet self-shielding moving coil mechanism. Model 1091 has a dc sensitivity of 25 microamperes for full scale. Contacts can be set as close as 5-0-5 microamperes. AC sensitivity is 50 microamperes for contact closure. Relay has a scale length of 14 degrees and maximum zero suppression is 14 scale lengths with a minimum of 10 microamperes on scale. It is connected in the rear and can be mounted flush on panels. Contact capacity is either 50 or 200 ma at 6 v dc, depending on the relay sensitivity. Contacts can be set as close as three degrees on zero left instrument or 3-0-3 degrees on zero center. **Weston Instruments, Div., Daystrom Inc.**, Newark 12, N. J.

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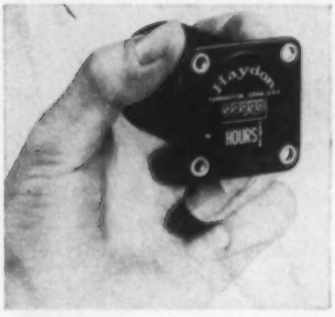

Elapsed Time Indicator

Item 474

Unit is applicable on machine tools, instruments, or wherever an accurate record of operating time is required. Model ED-71 is equipped with a direct reading, five-digit counter that records hours and tenths of hours up to 9999.9 and then repeats. It can withstand shock and vibration, will operate over a temperature range of −55 to +71 C. Indicator has a synchronous timing motor, is rated for 120 or 240 v ac at 60 cycles. Power required at 120 v is only 2.5 w nominal. Dielectric strength is 1000 v rms. Unit can be mounted either behind or in front of the control or instrument panel. **Haydon Div., General Time Corp.**, 245 East Elm St., Torrington, Conn.

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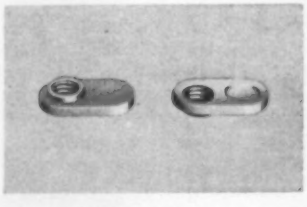

Spotweld Nut

Item 475

Adaptable to hopper fed operations, spotweld nut can be used with portable welders and rocker arm equipment which is used at an

angle. It is designed for applications where space is limited and maximum fastener strength is needed. Fastener can be welded to components with the same weld settings used to join assemblies. It is constructed with a circular recess with beveled edges to guide the weld tip into position. Another construction feature is the "Precision Pilot," a raised ring around the threaded area which is designed to fit in the smallest hole and provide maximum strength. The nut is available in thread sizes from 6-32 through 3/8-16. **Ohio Nut & Bolt Co.**, 33 First Ave., Berea, Ohio.

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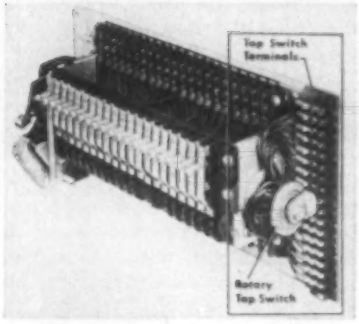

Step Switch

Item 476

Heavy duty unit has an optional rotary tap switch which can be used with indicator circuits or for interlock sequence control. The addition of the tap switch accessory increases the number of circuits to 36. Tap switch points can be used for pilot circuits such as lights and relay coils which are to be energized sequentially. Switch is available with 2 to 20 independent 10 amp circuits. It is driven by a rotary ac solenoid at speeds up to 300 steps per minute. Up to 16 steps per cycle are available with each circuit closed for one or more steps, depending on the cam breakouts. **Eagle Signal Corp.**, Moline, Ill.

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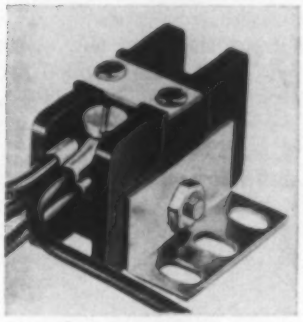
Pressure Terminal

Item 477

Construction of terminal combines an offset barrel with a depressed-center ring tongue which allows the lugs to be nested together in pairs and the pairs to be stacked vertically. This arrangement doubles the number of terminations on each board. The ring tongues fit together to provide lockwasher action which makes connections resist extreme shock and vibration. When the tongues are nested together, they form a series of fins to increase the cooling area and dissipate heat. The barrel of the lug has a beveled mouth for easy wire insertion; it also is equipped with V-grooves which securely grip either stranded or solid wire. **Panduit Corp.**, Dept. ANC, 14461 Waverly Ave., Midlothian, Ill.



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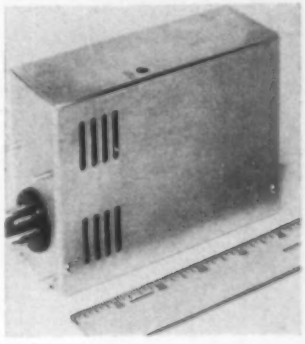
Power Supply

Item 478

Suitable for applications requiring stable, low level power, unit is designed for steady operation under continued vibration. Model PT 111 has a high current output, low heat generation, and six nominal voltages, ranging from 2.5 to 15 v dc, which are varied by a 10 turn potentiometer. It is regulated for stability with changing load under changing line voltage and with temperature variations.



Output voltage adjustment is made through the front panel. Power supply operates on 117 v, 50-60 cps

How fast do you want to drill...

10,000 RPM MAYBE 15,000 OR 20,000 ?

Oil-circulating head with vertical adjustment spindles.

U. S. Drill Heads are designed to drill as fast as you need—*and still maintain accuracy!*

The rugged Fixed Center Head shown is a full ball bearing, oil-circulating model with built-in pump. It operates regularly in production at 15,000 rpm with very little heat! As in all U. S. Heads, shaved gears assure quiet, smooth operation—at all speeds. Write for catalog FC-57.

US DRILL HEAD

Adjustable and Fixed Center Multiple Drilling Heads. Individual Lead Screw Multiple Tapping Heads.

UNITED STATES DRILL HEAD CO.

BURNS STREET • CINCINNATI 4, OHIO

Circle 695 on Page 133

input with output current of 200 ma continuous and nominal output voltage of 2.5 v, 5 v, 6 v, 10 v, 12 v and 15 v dc. Output voltage change is less than 0.4 per cent over a temperature range of 60 to 90 F. **Computer Engineering Associates Inc.**, 350 N. Halstead Ave., Pasadena, Calif.

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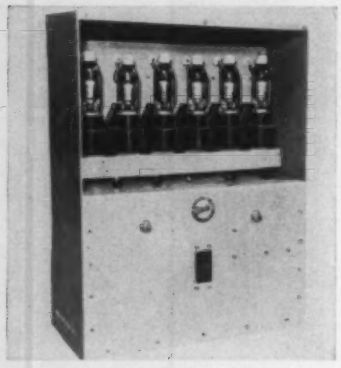

Servo Amplifier

Item 479

Device is designed for two-phase induction servomotors of ratings from ⅛ to 3 hp. It has a response of 0.008 seconds and is flat to 20 cps regardless of the power rating. Servo amplifier can operate from a 60-cycle, three-phase power supply, and control both reference and control phase of a motor. Unit features a low impedance grid control circuit which prevents thyratrons from being fired by external unwanted signals or noise. **Diehl Mfg. Co.**, Finderne Plant, Somerville, N. J.

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Power Transistor

Item 480

Suitable for use in static power converters and voltage regulators, power transistor is also adaptable as relay replacement and as high current switch. Two types (Model B-20-60 & Model B-50-100) are available with typical current gains of 40 and 75 at 10 amp. Collector-to-emitter breakdown voltage ratings of 30, 40, 70, and 80 v eliminate burnout in high voltage applications. Corresponding collector-to-base breakdown ratings are 20 v higher. Transistors are supplied in a package with soldering lugs, straight pins, or flying leads. **Semiconductor Products, Bendix Aviation Corp.**, Long Branch, N. J.

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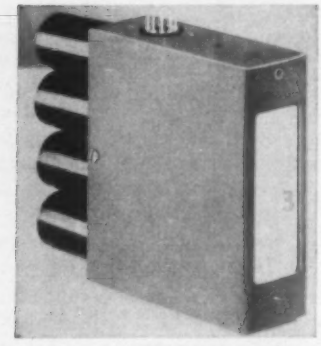


Decade Counter

Item 481

Transistorized instrument is capable of counting at rates as high as 150 kc. Model CT-101 has a visual display with ⅜-inch numerals which are back-lighted on a translucent plastic panel. The counter uses plug-in encapsulated flip-flop circuits, has a 9-pin socket which provides decimal or binary-coded decimal electrical output for remote indication. Power and input signals are fed to the counter through a 9-pin miniature plug. Power consumption is 120 mw and two supply voltages of −3 and −10 v are required to operate the unit. **Components Div., Epsco Inc.**, 108 Cummington St., Boston, Mass.

Circle 481 on Page 133

Master Control Valve

Item 482

Applicable in liquid handling operations, multiport pilot valve is a control using hydraulic pressure to actuate up to 36 remote valves from a single location, turning them on and off according to any preset sequence. It is available in two styles, one with six operating positions, the other with twelve. Each position controls the flow of pilot-line pressure to any one or any group of remote valves.

The pressure in the system, acting through small pilot lines, holds the valve disc assembly closed by pressing on a flexible diaphragm. The control opens the valves by interrupting this pressure, at the same time venting the pilot tube to the atmosphere. Line pressure lifts the diaphragm, allowing full flow to occur. All ports in the valve are controlled by the rotation of a single multiport disc. A supply tube, which is under pressure at all times, leads from the main line or independent pressure source. The multiport disc contains a concentric pattern of holes that match equivalent ports in the body of the control. Not all of the holes in the multiport disc are drilled straight through. A selected number of them are connected to cross drillings that lead to a drain located at the center of the control. As the disc is rotated, some of the control tubes leading to the remote valves receive line pressure, holding the appropriate valves closed. Other control tubes are connected to the drain, permitting the diaphragm in these valves to open.

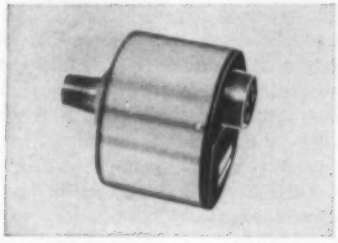
Each turn of the control moves the disc to a new position, changing the arrangement of valves receiving the supply pressure. When a supply hole in the manifold disc moves into position over a pilot tube connected with a valve that is open, the supply pressure immediately forces the diaphragm in the valve against its seat, closing off the flow of liquid through the valve. **Automatic Valve Systems Co.**, 1535 Monrovia Ave., Newport Beach, Calif.

Circle 482 on Page 133

Pressure Transmitter

Item 483

Pressure transmitter covers a range from 30 inches Hg vacuum to 50 inches Hg pressure, is designed for automotive and aircraft engine testing. Potentiometer outputs are available from 600 ohms to 5000 ohms resistance. Transmitter is rated for 1 w for ambient temperatures up to 50 C



and ½ w for temperature up to 70 C. Life of the unit is 3,000,000 cycles minimum. **Computer Components Div., International Resistance Co.,** 401 N. Broad St., Philadelphia 8, Pa.

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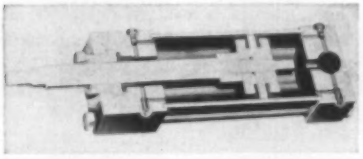

Cushioned Air Cylinder

Item 484

A nonprotruding, self-locking cushion adjusting screw is feature of cushioned air cylinders. The cylinder can be mounted on the side containing the ball check or adjusting screw assembly since no parts of it protrude beyond the flat, sidemounting surfaces of the cylinder head or cap. The adjusting screw and ball check assembly are interchangeable to provide better access for cushion adjustment.

Adjustments are made simply by turning the adjusting screw. If the cylinder is mounted in close quarters, the adjusting screw can be reached through a small communicating hole drilled in interfering machinery. Both assemblies are permanently sealed against external leakage, are impenetrable to almost all gases, fluids, liquids, and chemicals and can withstand temperatures from −100 to 450 F. **Miller Fluid Power Div., Flick-Reedy Corp.,** 2040 N. Hawthorne Ave., Melrose Park, Ill.

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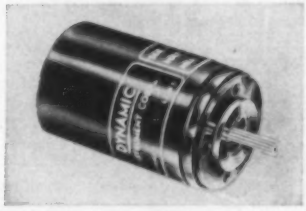

Miniature Servomotor

Item 485

Unit features rapid response, internal damping, high torque, rapid stall acceleration, and resistance to shock and high temperatures. It is applicable to automatic machine tools and processing equipment. Model M-100 is designed on a simplified stator and bobbin-wound coil. It can be wound for Class H use and for transistor operation. Push-pull and high voltage types (used for direct coupling to a driver amplifier) are also available. Where required, dielectric strengths of 2000 v can also be provided. **Dynamic Instrument Corp.,** 59 New York Ave., Westbury, L. I., N. Y.

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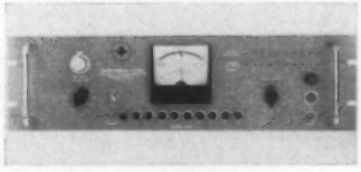

Reference Junction

Item 486

Unit is a temperature oven which encloses the junctions of thermocouple and copper lead wires. Stability is ± 0.15 F. This stability is achieved by matching the thermal load with the temperature control system. Unit will operate in ambient temperature ranges of 40 to 120 F. Nominal temperature set point is 250 F. Reference junction is rack mounted, has a low ac noise level. **Cardinal Instrumentation Corp.,** 4201 Redwood Ave., Los Angeles 66, Calif.

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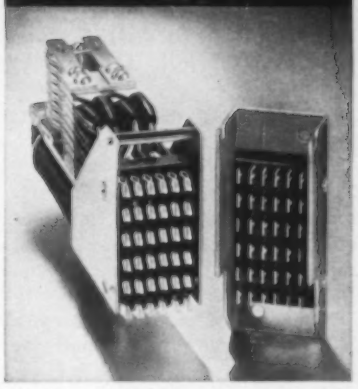
STROMBERG-CARLSON

Type "A" Relays with Plug-in mountings



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AUTOMATION abstracts

ELECTROHYDRAULIC SERVO SYSTEMS FOR MACHINE TOOLS

By R. K. SEDGWICK
Asst. Chief Engineer
Kearney & Trecker Corp.
Milwaukee, Wis.

THE electrohydraulic servo valve and its slave, the rotative hydraulic motor, make up a team which, for faithful adherence to instructions, is hardly to be surpassed among man-made mechanisms. Kearney & Trecker Corp. became interested in this combination of elements when this company decided to enter the field of servo-controlled machines several years ago. At that time, a task force was organized to determine the requirements for such a machine in general and for a servo-controlled feed drive in particular. It was felt that the greatest immediate usefulness for the principle would be in milling machine applications.

Ideal For Machine Control

Presently, the valve-motor team was consolidated in a drive with the recirculating ball screw, and the whole rig placed under the direction of a tape reader. There are several reasons why these servo control elements are well suited for machine tool use:

1. The ability of the rotative hydraulic motor to accelerate rapidly under the influence of relatively small torques releases more of the available torque to be used in accelerating the machine slide and its load. Since this means slowing them down as well as speeding them up, it is possible to get the slide and load where they are wanted rapidly and stop them with a minimum of overshoot. In addition, the extremely rapid response permits quick adjustment of the speed, improving the regulation.

2. The entire mechanism is so stiff that it can withstand these rapid changes without appreciable elastic deflection which, when it occurs, introduces errors and encourages oscillations in the system.

3. The servo valve enables a small amount of electric power to control a very large amount of hydraulic, and subsequently mechanical, power. This results in the control components being generally small both in size and capacity, making practical such arrangements as printed circuits, transistors, and even a certain amount of encapsulation of electronic elements. Systems requiring large amounts of electrical power at this point utilize more relays, tubes, rotating generators, stepping switches, and the like.

4. Within limits, the performance of the arrangement may be improved by raising the hydraulic pressure, which is a very simple operation in most cases. The over-all duty cycle of the motor used to drive a lead screw on a milling machine is very low, so that the motor can be driven hard for short periods without reducing its life by an appreciable amount. Most of the time the servo valve is throttling the oil to such a degree that the pressure at the motor is quite low, and the motor experiences the full pressure for only a small fraction of the total time.

None of the above items take into account the many detail refinements available through the superior properties of servo valves. The servo valve is the "high fidelity" element in the machine, and it has been the job of the machine designer to bring the performance capabilities of the rest of the machine up to where he can make good use of what the servo valve can do.

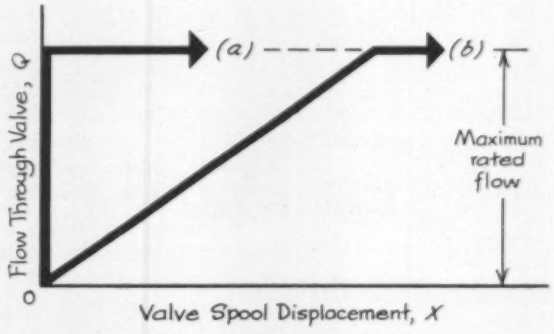

Fig. 1—Operating characteristics of idealized directional control valve (a) and servo valve (b) point up a basic difference between them. Directional control valve has two modes of operation; zero flow and maximum rated flow. Servo valve permits flow proportional to valve spool displacement over its entire range.

What Is A Servo Valve?

It would be appropriate at this point to discuss just what a servo valve is and how it differs from its nearest conventional counterpart, the four-way directional control valve. To be sure, it resembles a directional control valve in its usual configuration, but its action differs in some important ways, *Fig.* 1. Generally, the four-way directional control valve has

three positions, i.e., neutral, and two extreme positions. The latter positions cause the delivery to the load ports to be reversed or interchanged. In either of the extreme positions, the directional control valve delivers oil to one of the load ports and receives oil from the other, which it returns to the tank. Sometimes the valve is set up so as not to dwell in the neutral position. In either extreme position the four way directional control valve delivers all the oil it is capable of handling, or all that is available, into one of the load ports.

By contrast, the servo valve has, in theory, an infinite number of positions on either side of neutral. When in these various positions it acts as a throttle, and controls the amount of oil flowing into the load ports. Since it also controls the amount of fluid flowing out of a load port into the tank, it has a pretty good hold on the load from both sides. By carefully adjusting the proportions and in some cases by careful individual adjustment, the servo valve builder renders the relationship between the input signal and the hydraulic output nearly linear. Perfect linearity is the goal usually sought, since the best servo system is generally that one which has the fewest and smallest nonlinearities.

It should be emphasized that the ordinary servo valve does not automatically compensate for changes in pressure or load resistance as does the flow control valve. In any given position, the servo valve acts as a pure throttle, and a change in pressure drop across it will result in a change in flow rate. Most systems in which it is used, however, have some sort of governing or regulation, so that unintentional variations are compensated for by an automatic change in the valve position.

How Does It Operate?

With these general characteristics in mind, let us look at the actual mechanism of an electrohydraulic servo valve, and see how it operates. The first thing worthy of note is that a small amount of electric current, in the milliamperes, operates a fairly large valve spool, and does it very rapidly. In only a very few cases is this done directly by virtue of the magnetic forces available from the current passing through coils. In the sizes we are concerned with, it is done by staging, or piloting. In this arrangement, the coils move a small intermediate element, and the output of this small element, in the form of hydraulic power, is utilized to move the main spool.

Traditionally, staging is done by having a solenoid or other electric coil device move a small valve spool, and this same scheme is used in some servo valves, *Fig. 2a*. Of course, the solenoid as we know it is not suitable because it has only two positions, *in* and *out*. What is needed is a torque motor that operates against spring force, so that the deflection is more or less proportional to the input current.

If a torque motor is used to shift the main spool of the servo valve through a standard pilot valve arrangement, the speed of main spool shift will be governed by the torque motor deflection, but the amount of shift will not. To accurately position the main valve spool, one more element is needed—a position feed-

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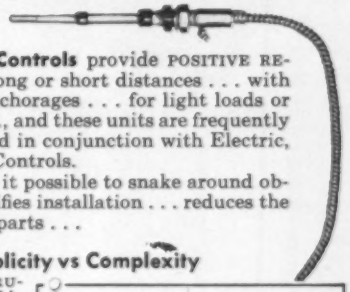

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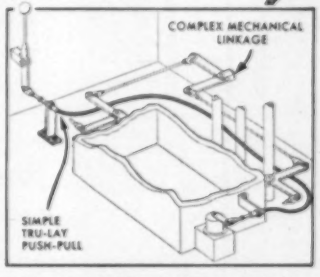

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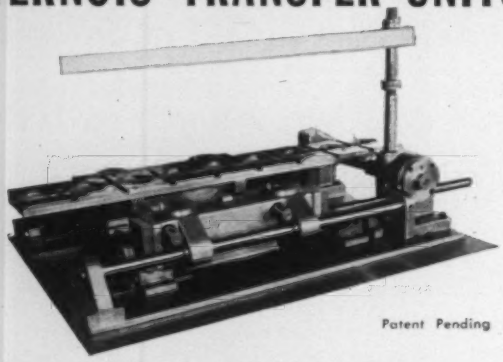

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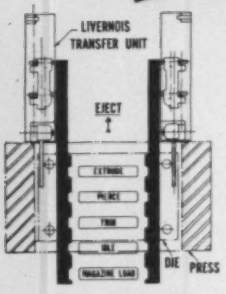

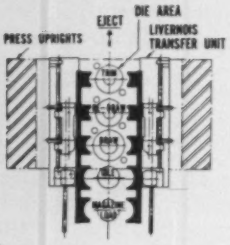

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back device. This can be in the form of a linkage connecting the main spool of the servo valve with the spool of the pilot stage. When this combination of elements has been assembled, the conditions for accurate positioning of the servo valve spool are fulfilled. The torque motor produces an initial deflection nearly proportional to the current, and through the intervention of the feedback means, the motion of the main spool is likewise nearly proportional. The operation is simi-

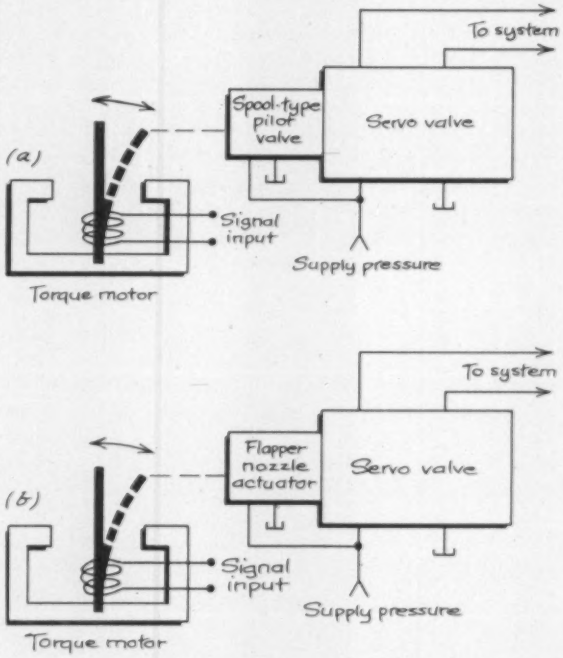

Fig. 2—Electrohydraulic servo valves often employ an intermediate amplifying element between the torque motor that receives electrical signals and the main servo valve that controls hydraulic flow. Pilot valves (a) and flapper-nozzle actuators (b) are two common types of intermediate elements used.

lar to that of the solenoid actuated, pilot operated four-way valve, but with two important exceptions—the pilot valve can assume an infinite number of positions and the main spool of the servo valve duplicates this motion on a larger scale.

Another type of mechanism, *Fig. 2b*, is commonly used in place of a pilot valve to multiply the power of the torque motor. This device utilizes a pair of jets connected by passages to pilot chambers at the ends of the main servo valve spool. Oil continuously issues from these jets and is passed off to the tank line. If the flow of oil from these jets is interfered with, a pressure rise will result in one of the pilot chambers, and the main spool will move. In practice, the mechanism is arranged so that some of the interference is removed simultaneously from the opposite jet, causing a pressure drop in the opposite pilot cham-

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ber that assists moving the spool. The necessary interference to flow is produced by a paddle held up against the issuing jet streams, and the resistance is changed by holding the paddle closer to or farther from the jets or nozzles. This is known as the flapper-nozzle arrangement, and is capable of very high performance as a power amplifier partly because of the extremely low inertia of the flapper. In some cases the flapper is positioned between the two nozzles so one flapper does for both; in other cases, there is a separate flapper for each nozzle.

Valve Selection

It is not intended by the above description to cover the ground well enough to enable one to form opinions about the suitability of a particular type for a particular application, but rather to introduce the two popular types so that they can be referred to by name. It is appropriate, however, to mention some properties of these types that influence our thinking when the question of valve selection is at hand.

When typical servo valves using each of the above types of intermediate elements are compared, significant physical and operational differences are discovered. Valves of the flapper-nozzle type seem to have one dominating characteristic, namely, compactness. Some can be concealed in the vest pocket. Another characteristic of this type is its light weight. Every effort is customarily made to keep the weight down, with the result that we see aluminum bodies with steel inserts, small screws closely spaced, and a good deal of safety wiring of screws to prevent loosening. The small size of the screws is quite a shock to the machine tool man accustomed to making things too strong. In fact, some of these valves are simply not strong enough, and we have had some spectacular wrecks occur when, through the malfunction of some other element, an unexpected amount of pressure suddenly became available at the servo valve. This is particularly dangerous when pressure gets into that part of the valve normally subjected only to the tank line pressure. In the machine tool and machinery business generally, we like to have equipment that will take an occasional kick in the tank line without coming apart! Some servo valves will, and some won't.

When we examine the pilot spool type of valve, we often find the opposite treatment. It seems the designer of these valves starts with a generous chunk of steel and carves it out to provide the necessary passages and chambers, while leaving a goodly amount of steel around the outside. This provides plenty of material for strength, room for large screws to hold the assembly together, and room for more large screws to mount the valve securely to the motor. With this type of construction, extraneous and unpredictable loads are not likely to remove the valve from the motor.

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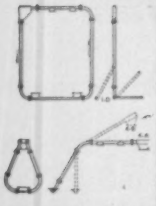

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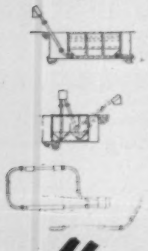

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of the flapper-nozzle valve has been excellent, particularly in the case of its dynamic characteristics. It is customary in the testing of these components to attach a signal generator to the input and shake the whole system at various frequencies while checking the performance on an oscilloscope. Under this kind of treatment, the characteristics of both types of valve are far better than the ability of a machine to follow, yet some interesting differences are apparent. Tests made recently to aid us in the selection of valves have indicated the following about flapper-nozzle types:

1. The flapper-nozzle arrangement enables the valve to give good response at quite high frequencies, and this is readily translatable into improved machine performance.

2. The linearity between signal input current and gallons per minute is most gratifying for the flapper-nozzle, particularly in the region near zero deflection where so much of the accurate work is done on a milling machine.

3. In coming off zero current, a point is reached where the valve begins to move and change the flow conditions. This is the "threshold" point, and, of course, everyone wants it to be as near zero as possible. To attain this, it is desirable to have as little friction in the mechanism as can be had. The flapper is ideal for this purpose because it is only waving around in the space between the nozzles, and is not touching anything.

4. Sometimes a valve will drift over a period of time in response to temperature changes and other disturbances. This means that the neutral or null point moves, and current must be applied to correct for the motion. Here, too, the flapper makes a good case for itself. Perhaps this is because there is so little to the flapper that it cannot change much with temperature, but it is also likely to come from the fact that the length change of the flapper does not change its lateral position, whereas the length change of the operating stem in a pilot spool will decidely change the spool position unless the body changes exactly the same amount. Occurrence of the latter is too much to hope for.

System Regulation

Regardless of the type used, the response of a good servo valve to changes in signal level is so prompt, and in so nearly the right amount, that corrections are made at almost the same time they are detected by the feedback device. A slide motion rate that is controlled by tachometer feedback, for instance, may be reduced momentarily by a slight change in friction or cutting load, but the detection and correction are so rapid that the error exists for only a short interval of time. The magnitude of the actual velocity change, and the amount of slide motion lost, are generally of no consequence. The little motion lost can be made up by the signal from a position feedback device if position is important. The superior regulation shows up in better finish, closer tolerances, and increased cutter life.

One thing we would like to see above all else is a servo valve that would have the strong construction typical of some of the pilot spool type valves com-

bined with the performance characteristics attainable with the best flapper-nozzle types. This should not be difficult when the quest for extreme compactness and light weight is abandoned. We feel confident that the expanding market for servo valves in other than airborne applications will stimulate valve makers to provide this combination of properties. Another field for improvement is in the direction of more standardized electrical connections. Multiple prong plugs are generally used, and it seems that the one we need at any given moment is out of stock. Another area in which more work could be done concerns the mounting dimensions of the valve itself. It would be desirable to have interchangeability between makes and between types if this is at all possible. It is gratifying to note that some progress has already been made along this line.

From a paper entitled "The Electrohydraulic Valve As A User Sees It" presented at the Vickers Machine Tool Hydraulics Forum, Detroit, May 1958.

SYSTEMS APPROACH TO AUTOMATION

By ALLAN HARVEY
President, Dasol Corp.
New York, N. Y.

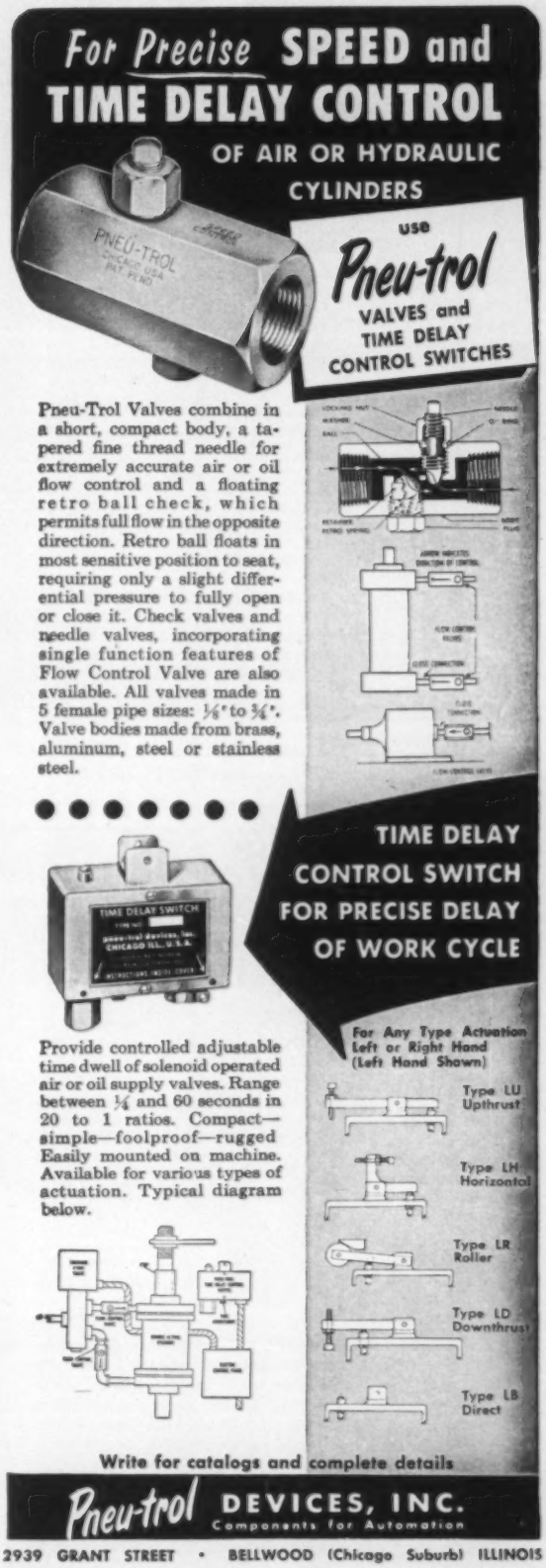
FOR ALL practical purposes automation engineering equals systems engineering. I have taken this position as an antidote to the confusing view that automation has to do with expensive hardware and therefore is appropriate only for big firms with big volumes and big budgets. On the contrary, some of the most successful installations incorporating automation have been for relatively small companies with small volumes and small budgets.

New Concept

Systems engineering is admittedly a complex concept, but business itself is becoming increasingly complex. We therefore need a new technology and a new set of engineering concepts. The reason is simple: Mass production presents relatively simple engineering challenges in that a relatively small number of things are done a relatively large number of times. In distribution operations, paperwork, data processing, and in the demands for flexibility of operation, however, much more complex and ever-varying details are involved. For the most part such activities require that a large number of different things be done a very few times.

This brings us to a new era in engineering—an era in which we are beginning to apply new concepts and technologies. Just as Henry Ford discovered that in linking together bits and pieces he could achieve greater production efficiencies, we now find that by looking at the business as *one system* we can achieve greatest possible efficiency for the total business operation.

This is the definition of systems engineering. It is an activity which investigates, analyzes, and designs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OF AIR OR HYDRAULIC
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VALVES and
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PNEU-TROL
Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check valves and needle valves, incorporating single function features of Flow Control Valve are also available. All valves made in 5 female pipe sizes: ⅛" to ¾". Valve bodies made from brass, aluminum, steel or stainless steel.
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FOR PRECISE DELAY
OF WORK CYCLE
Provide controlled adjustable time dwell of solenoid operated air or oil supply valves. Range between ¼ and 60 seconds in 20 to 1 ratios. Compact—simple—foolproof—rugged Easily mounted on machine. Available for various types of actuation. Typical diagram below.
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(Left Hand Shown)
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Circle 701 on Page 133

Simplify your Control Wiring with —

CURTIS Type "BT" Terminal Blocks

Here is your answer to orderly, simplified safe control wiring. You can have the Type "BT" Block factory assembled with any number of terminals from 1 to 30. Each Terminal bar is provided with a screw connection at each end. Combination of screw and solder terminals are available designated as the "BS" Block. White marker strip for circuit identification. Rated 30 amperes, 750 volts.

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Ask for Bulletin DS-110. Also learn about wide selection of other available Curtis Blocks.

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Circle 702 on Page 133

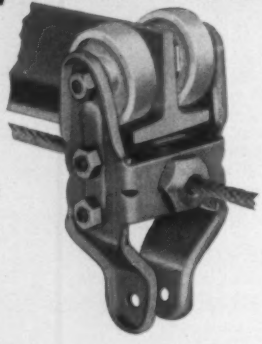
CLEAN!

AMERICAN "Cable-Way"® Conveyor with NYLON WHEELS

Open T-rail track and trolleys are easily cleaned, with water or air hose.

Adaptable for explosion-proof installations.

Nylon wheels are almost noiseless.



No grease drippings. Most installations require no lubrication. Others minimum amount. Can be water-lubricated.

Galvanized or stainless steel cable.

Operates in moist conditions with minimum of maintenance.

The American "Cable-Way" Conveyor with nylon-wheeled trolleys requires grease lubrication only on the motor drive and idler sprockets. All-bolted track and suspension system makes installation fast and easy. Low-cost and dependable. Handles loads up to 250 lbs. per trolley.

← *(Left) Steel wheels are also available for average industrial installations.*

CONVEYOR DIVISION

THE AMERICAN MONORAIL CO.

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Circle 703 on Page 133

with a view to the relationship of each function to the total business. As applied to materials handling, for example, it recognizes no artificial barriers between the warehouse and the rest of the business, between materials handling and paperwork handling, or between any of these operations and the types of information that management needs in the control of the business. It traces each potential inefficiency to its source and deals with it at the earliest point at which it can be controlled. It follows each operation, integrates it smoothly into what follows, and does not of itself cause a wasted motion, a bottleneck, an idle machine, or an idle man.

Applies To Any Business

As a way of thinking about business operations, systems engineering applies to any size or type of business regardless of the product and its requirements. It also presents an appeal for ideas before hardware; once a system has been thought through it can be equipped with a little or a lot of simple or complex hardware.

Application of the systems concept to business or manufacturing problems promises these benefits: 1. Increased efficiency of existing operations without additional mechanization. 2. Economic justification of additional mechanization by employing equipment more efficiently. 3. Permits greater use of automatic equipment and controls. 4. Broadens the scope and effectiveness of management planning.

Systems engineering has something for everyone. In its challenge to management and the engineering profession, progress will depend on our creative ability to use its potential.

From a paper entitled "The Systems Engineering Approach To Materials Handling" presented at the ASME Materials Handling Conference in conjunction with the Fourth International Automation Exposition and Congress, New York, June 1958.

RADIOISOTOPES IN INDUSTRY

By PATRICK J. SELAK and RUDOLPH TIETIG, Jr.
Henry J. Kaiser Co., Oakland, Calif.

PAPER describes various applications of radioisotopes in steel plant operations. Use of nuclear energy as a source of supplemental process heat in areas of high fossil fuel costs is discussed. Applications given include radiography, gaging, and radiotracers. Operations covered include preparation of raw materials, production of coke and byproducts, blast furnace processing, production of steel ingots, rolling and finishing, inspection, and quality control. Health and safety problems are mentioned.

From a paper entitled "Nuclear Energy Applications to Steel Plant Operations" presented at the 1958 *Iron and Steel Convention of the AISE, Cleveland, Sept.* 1958.

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 1621-P

AUTOMATIC TESTING MACHINE

. . . I am investigating automatic checkout and test equipment of the "Go-No-Go" or "Low-Go-Hi" type. Could you provide me with the names of companies engaged in this work. I am interested in both consultation service and manufacture of the equipment. If possible, I would like the companies with five or more years experience in this field. Thanks for any information . . .

Project Engineer

CASE 1657-P

CONTINUOUS FEED SHEARING

. . . I would like to take advantage of your services in regard to a mechanical development problem. Present operational equipment handles material ranging 0.003 to 0.010 inch in thickness, fed intermittently through a punch and die.

The new design under consideration incorporates a continuous feed of material, and the information we seek involves a rotary shearing process by which we can form our material without losing any of our expected speed of 400 to 500 linear feet per minute. Angles of shear will vary from maximum to minimum allowable, while the material is wrapped about a roller or drum. Any information on this type of operation will be greatly appreciated . . .

Machine Designer

CASE 1643-P

AUTOMATIC WHEEL ASSEMBLY

. . . We wish to obtain a fully automatic machine to assemble polyethylene wheels to steel axles. The wheels are molded in an injection molding machine and are 1-7/8 inches in diameter and 5/8 inch thick. There is a hole in the center for a 0.120 inch diameter axle 3-13/32 inch long. The wheels are also to fit another axle of the same diameter but 4-17/32 inches long. We hope that you will be able to find a suitable supplier . . .

Plant Manager

SUGGESTION FOR 1954-P (AUG. 1958)

SENSING HEADS

. . . We are enclosing a circular on a dial indicator, the CEJ Mikrokator No. 502. This small and accurate indicator might be useful . . .

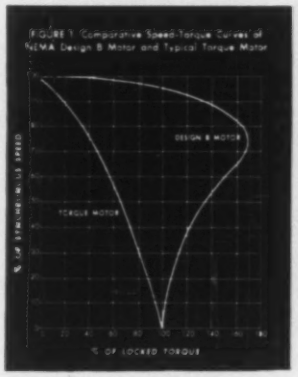
Edward Johansson
C. E. Johansson Gage Co.

SELECTING TORQUE MOTORS

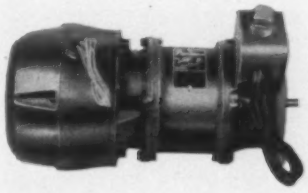
The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 oz. in. to 200 lb. ft.

Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

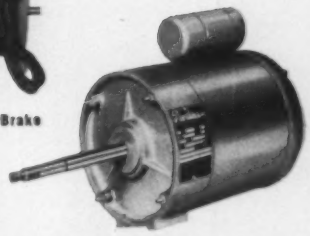
All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments; and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.



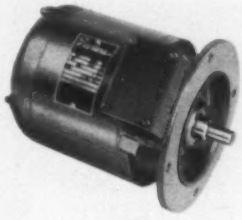
The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.



Explosion-Proof Torque Motor With Brake



Special Flange Reversing Hoist Motor Single Phase



Weather-Tight Special Flange

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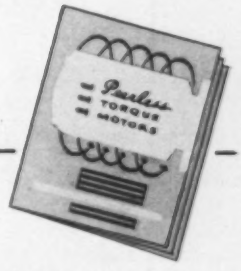
This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available **Free.** Write for it today.



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Instrumentation for Better Analysis

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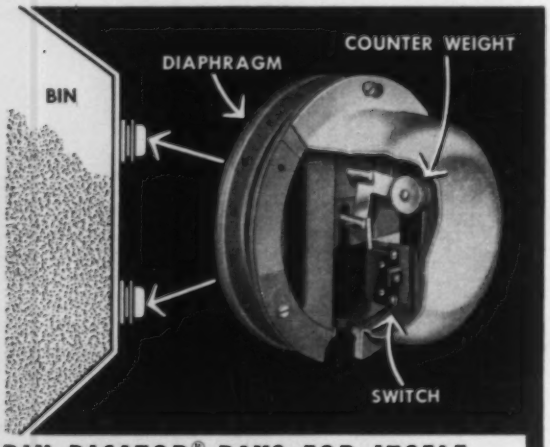

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PHOTOSENSITORS

By W. Summer; 675 pages, 5¼ by 8½ inches, published by Macmillan Co., New York; available from AUTOMATION; $21.00 *postpaid.*

Term photosensitor has been coined by the authors as a generic term for any type of photoelectric device. The scope of this book is therefore very broad since the author discusses not only types of photoelectric devices but also basic circuits, applications, and complementary equipment. Applications examined include protective devices, production control, temperature control, inspection, level indication, counting, and other uses.

DICTIONARY OF PERSONNEL AND INDUSTRIAL RELATIONS

By Esther R. Becker; 366 pages, 6 by 9¼ inches, clothbound, published by Philosophical Library, New York; available from AUTOMATION; $10.00 *postpaid.*

Definitions of terms used in personnel and industrial relations are presented in dictionary format. More than 2400 entries and 500 cross-references are claimed to cover labor relations, union activities, company practices, training, health, and welfare. Associations, publications, and colleges dealing with personnel and industrial relations are listed.

SWITCHING CIRCUITS AND LOGICAL DESIGN

By Samuel H. Caldwell, professor of electrical engineering, Massachusetts Institute of Technology; 686 pages, 5¾ by 9 inches, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; $14.00 *postpaid.*

Thorough textbook discusses methods for design of switching circuits. Symbols and principles are covered and sample problems are included with each chapter. Circuits discussed include those with electronic and solid state devices as well as contact elements in series-parallel, multiterminal, iterative, non-series-parallel, and sequential networks. Minimization methods and switching aspects of codes are also treated.

HANDBOOK OF AUTOMATION, COMPUTATION, AND CONTROL—VOL. 1

Edited by Eugene M. Grabbe, Simon Ramo, and Dean E. Wooldridge, all of Thompson-Ramo-Wooldridge Inc.; 1015 pages, 5¾ by 9 inches, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; $17.00 *postpaid.*

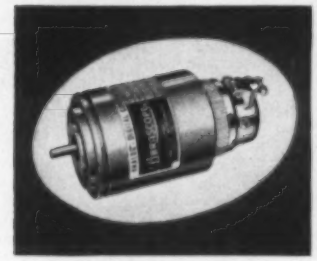
Works of 29 people are combined in this first volume, which is devoted to control fundamentals. Major sections cover general mathematics, numerical analysis, operations research, information theory and transmission, and feedback control. Copious references are given for each chapter.

Analog-Digital CONVERTERS

Packaged units for conversion of Shaft Position-to-Digital Code for Computers and Data Handling Systems

Types: Librascope offers these converters with outputs in Binary, Binary Coded Decimal and Grey code.

Capacities: In Binary, four models with capacities of 7, 13, 17 and 19 bits available, i.e., Model 707, 713, 717, and 719. In Binary Coded Decimal; four models with capacities of 2000, 20,000, 3600 and 36,000 counts are available, i.e.,Models 723, 724, 733, and 734. In Grey code one model with a capacity of 8 bits is offered, i.e., Model 708.



Features: Reliability, accuracy, small size ruggedness, long life and high speed capabilities are the features which have established Librascope converters as leaders in the field. Utilizing a staggered, double brush pick-off which provides the means for unambiguous readout they can be read serially or in parallel with equal facility. Time sharing of many converters with a single computing element is accomplished with isolation diodes which are mounted internally on special order.

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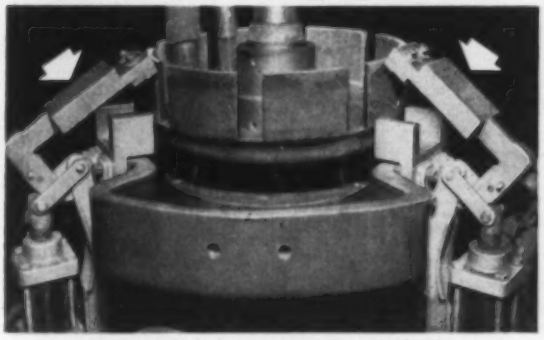
Construction: All units are Synchro mounted. Materials of the highest quality non-corrosive and non-fungus nutrient properties are used throughout. The units are small in size compared to their capacities.

For additional information write for catalog E10-1. Address Librascope, Inc., subsidiary of General Precision Equipment Corp., 816 Western Avenue, Glendale, California.

Circle 707 on Page 133

BIG--for big jobs



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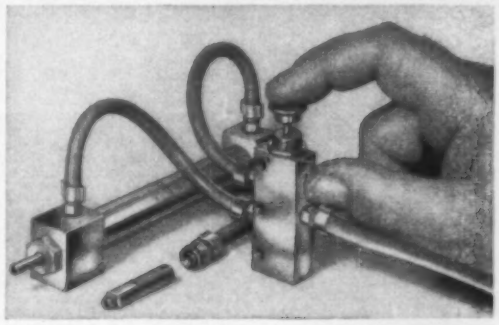
NEW! MORE Powerful 9/16" MINIATURE AIR CYLINDERS · 4-WAY AIR VALVES · QUICK CONNECTS



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July - Dec., 1958

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AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

TREATING PARTICULATE MATERIALS

Automatic conveyor intermittently moves packages of detergent material underneath an upraised nozzle. Control devices automatically actuate a pneumatic cylinder to move the nozzle into and out of package, operate a solenoid valve to discharge liquid perfume and a gaseous propellent into the detergent on the downstroke, close valve on the upstroke, and operate conveyor to remove package. Patent 2,825,190 by Robert Franklin Heald, assigned to Colgate-Palmolive Co.

AUTOMATIC COIN WEIGHING MACHINE

Unknown circular object and a standard weight are rotated about a vertical axis perpendicular to the midpoint of a line joining the centers of the two objects. Comparative weight of the unknown object is determined by detecting the amplitude of the variation of the center of mass formed by the two objects. Patent 2,826,079 by Milton L. Kuder, Ervin C. Palasky, Maurice L. Greenough, and Saul R. Gilford, assigned to the United States of America.

APPARATUS FOR MEASURING HARDNESS

Continuously moving strip is periodically contacted by a means for making an indentation of predetermined depth. Force required to indent strip is converted by piezoelectric means to an electrical potential which is related to the amplitude of the force and is a measure of the hardness of the strip. Patent 2,834,203 by Ernest S. Sampson, assigned to General Electric Co.

DEVICE FOR NON-DESTRUCTIVE TESTING OF MATERIALS BY MEANS OF SUPERSONIC PULSES

Apparatus transmits a supersonic ray into a workpiece. Size of internal fault is determined by comparing the scattering reflection caused by the fault with the scattering reflection caused by a reflector of known area on the back surface of the material. Patent 2,838,930 by Josef Krautkramer and Herbert Krautkramer, assigned to Sperry Products Inc.

ELECTROSTATIC SEPARATION METHOD

High difference of electrical potential maintained between a conveying electrode and a rotating electrode is used to preferentially separate and attract one component of a mixture toward the rotating electrode. Separated component is pneumatically removed from the rotating electrode. Patent 2,839,189 by Herbert B. Johnson, assigned to Quaker Oats Co.

GRADING AND REJECTING DEVICE

Small hard objects pass under an adjustable roller of resilient material. Roller applies pressure on objects and crushes imperfect units which are structurally weak, have low density, or are oversize. Patent 2,839,252 by Victor C. Hall, assigned to F. J. Stokes Corp.

APPARATUS FOR TURNING CIGARETTES

Cigarette is delivered transversely to the entrance of a funnel shaped passageway. Air flowing down one side of passageway causes cigarette to turn lengthwise into passageway and to move into an arcuate configuration at end of funnel. This configuration continues to turn cigarette until it has completed an end-for-end turn and is deposited on a collecting belt. Patent 2,840,222 by Warren G. Palmer, assigned to American Machine & Foundry Co.

AUTOMATIC TAPING MECHANISMS

Machine applies strip of tape longitudinally to the front end, top, and trailing end of a carton as unit is conveyed past electrically-operated dispenser. Mechanism includes means for severing tape strip before application on trailing end. Patent 2,841,305 by Arnold J. Werner, assigned to Wagner Iron Works.

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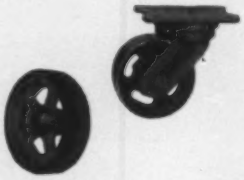

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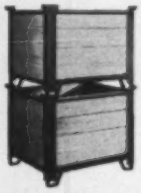

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Circle 712 on Page 133

new catalogs..... latest literature

Dry Fluid Drives

Dodge Mfg. Corp., Mishawaka, Ind.—24 *page booklet*—Ten stock couplings and eight stock drives ranging from fractional to 1000 horsepower are covered in Bulletin A640B. Advantages are discussed, such as protection of motors and driven machinery against damage due to overload and the absence of slip at normal running speeds. Tables are listed to aid in selecting the proper drive for normal and heavy-duty service. Also included are installation photos showing the different applications.

Circle 487 on Page 133

Strapping Equipment

A. J. Gerrard & Co., 1950 *Hawthorne Ave., Melrose Park, Ill*—52 *page catalog*—Data are given on automatic strapping equipment and materials. Types of equipment described are machines for flat steel strapping, round steel strapping, and units which use pressure sensitive tape. Types and finishes, physical properties, and characteristics are covered.

Circle 488 on Page 133

Electric Heating Devices

General Electric Co., Schenectady 5, N. Y.—52 *page catalog*—Electric heaters and heating devices are described in Bulletin GEC-10051. Data are given on pipe heaters; thermostatically controlled immersion heaters; one-inch diameter water immersion heaters; and immersion, strip, cartridge, and tubular heaters. Various heating processes are discussed and solutions to typical application problems are given.

Circle 489 on Page 133

Labeling Machines

Special Products Div., Markem Machine Co., Keene 80, N. H.—8 *page bulletin*—Machines are described which are capable of direct-marking components, parts, and packages with the U. L. manifest label legend. Data such as maximum object size, imprint area, and operating speed are given and various applications are noted for the line of machines.

Circle 490 on Page 133

Readout Cells

Semiconductor Div., Hoffman Electronics Corp., 930 *Pitner Ave., Evanston, Ill.*—4 *page pamphlet*—Photo-voltaic readout cells described in Bulletin 33-58 are suitable for applications requiring detection and power conversion of light energy passing through coded holes. Principle of operation is explained and a sketch shows the construction and operating details of a cell section. Charts illustrate current-voltage curves, spectral response curves, and variation of available power according to temperature changes.

Circle 491 on Page 133

Automatic Controls

Production Instruments Div., General Controls Co., 8080 *McCormick Blvd., Skokie, Ill.*—44 *page catalog*—Data on line of automatic controls are given. Included in the line are units such as switches, valves, actuators, counters, instruments, potentiometers, and combustion safety controls. Specifications, applications, and features are noted.

Circle 492 on Page 133

Cylindrical Grinder

Landis Tool Co., Waynesboro, Pa.—4 *page pamphlet*—Bulletin CD-58 reports how automation can be applied to a plain cylindrical grinder. Photos show the different work set-ups and a schematic drawing illustrates the loading, unloading, and gaging sequence.

Circle 493 on Page 133

Conveyor Systems

Conveyor Systems Inc., 6451 *Main St., Morton Grove, Ill.*—8 *page bulletin*—"Power and Free Trolley Conveyor Systems" is the title of Bulletin RSK-1. It discusses the advantages of using a free-running line which branches from the main circuit of power conveyors. Some of the points covered are remote controls, automatic dispatch, and supplemental systems.

Circle 494 on Page 133

Weather Protected Motors

Louis Allis Co., 427 *E. Stewart St., Milwaukee 1, Wis.*—6 *page pamphlet*—Motors suitable for outdoor use in the chemical, petroleum, and paper processing industries are described in Bulletin 2550. Cutaway drawings show how the motors are constructed for outdoor operation. Ventilation features are also noted.

Circle 495 on Page 133

Flow Switches

McDonnell & Miller Inc., 3500 *N. Spaulding Ave., Chicago 18, Ill.*—4 *page pamphlet*—Line of flow switches, outlined in Bulletin FS-1, can be used to light signals, sound alarms, and start or stop motors, burners, or metering devices. Operation of the switches, which respond to the flow of liquid in a pipe line to make or break an electrical circuit, is explained. Also included is a flow diagram showing the use of the switches in a typical industrial air conditioning system.

Circle 496 on Page 133

Shaft-Mounted Speed Reducers

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—24 *page catalog*—Shaft-mounted speed reducers are the subjects of Book 2618. Data are given on single reduction drives in six sizes, with nominal ratios of 5 to 1 and capacities up to 50 hp; and double reduction drives in seven sizes, with nominal ratios of 15 to 1 and up to 40 hp. Notes on lubrication, precision housings, bearing seals, and mounting styles are given.

Circle 497 on Page 133

Hydraulic Presses

Hydraulic Press Mfg. Co., Div., Koehring Co., Mount Gilead, Ohio—12 *page booklet*—Four automatic C-frame presses are discussed in Bulletin 58-CPA. These units can be adapted for applications such as forming, drawing, stamping, shaping, and crimping. The electrical controls and hydraulic interlock are explained. Accessories which are described include: Benches, oil coolers, bolster plates, and index tables for 6, 8, or 12 stations.

Circle 498 on Page 133

Control Cables

Triangle Conduit & Cable Co. Inc., New Brunswick, N. J.—4 *page pamphlet*—Control cables and their uses in automatic plants are discussed in Bulletin CC-10. The color coding system is explained, and the different sheaths and insulations which are available are listed. Also included are suggestions for selecting the proper type of control cable.

Circle 499 on Page 133

Preamplifiers

Control Div., Magnetics Inc. Box 391, Butler, Pa.—8 *page bulletin*—Preamplifiers, which are used to receive and amplify signals too small for large reactors, are described in Bulletin P-15. Their characteristics are discussed and their application in instrumentation, low energy regulating systems, and process control work are mentioned. Typical circuits, di-

new catalogs..... latest literature

mensional outlines, and physical and electrical curves are given.

Circle 500 on Page 133

Hydraulic Turret Drills

Burg Tool Mfg. Co. Inc., 15001 S. Figueroa St., Gardena, Calif.—12 page booklet—Two automatic hydraulic turret drills are described—Model 2BH (six spindle) and Model 3BH (eight spindle). Directions are given for setting up the unit for operation; this includes preselected speed changes, depth control, and feed rates for each spindle. Also discussed are automatic tape control models which position the machine table, select machine spindles, and operate the machine to carry out a predetermined sequence of operations.

Circle 501 on Page 133

Assembly Machine

Gilman Engineering & Mfg. Co., Janesville, Wis.—6 page pamphlet—Straight line machine is described which is capable of being converted to variety of assembly jobs. Photos show the features of the machine and a detailed sketch explains the basic feed mechanism. Other sketches show the components which assure successful operation in varying setups.

Circle 502 on Page 133

Coil Splicing Equipment

E. W. Bliss Co., 1375 Raff Rd. S.W., Canton 10, Ohio—4 page pamphlet—Coil splicer, designated Splice-A-Matic, is the subject of Bulletin 43-A. The equipment is designed to end-weld strip automatically to provide a continuous flow of strip to a processing or fabricating operation. Diagrams explain the principle of operation and sketches of typical arrangements of coil build-up lines are given.

Circle 503 on Page 133

Electrical Contacts

Contacts Inc., 1100 Silas Deane Highway, Wethersfield, Conn.—8 page bulletin—Solid rivets, button contacts, and contact assemblies are among types of precision electrical contacts described. Specifications and typical properties of materials are outlined. Tables list data for the selection of the proper contacts.

Circle 504 on Page 133

Gravity Conveyors

Conveyor Specialty Co. Inc., 33 Newport Ave., North Quincy 71, Mass.—6 page pamphlet—Conveyors and conveyor systems are outlined in Bulletin CL858. Types of units include: Horizontal belt conveyors, inclined belt conveyors, and live-roll and gravity conveyors. The bolt-together construction is explained and the company's engineering service discussed. Also included is a sketch of a typical 2-floor conveyor system.

Circle 505 on Page 133

Liquid Level Controls

B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.—16 page booklet—Floatless liquid level control systems which operate with an induction type relay and fixed electrodes mounted in a tank are described. The principle of operation is explained and the different types of liquid level relays and coils are related. Data are included on other components in the system such as signals and alarms, alternators and electrode holders.

Circle 506 on Page 133

Automatic Parts Feeders

Radio Corp. of America, 13541 Auburn Ave., Detroit 23, Mich.—8 page bulletin—Data on line of automatic parts feeders are contained in Bulletin 3R3384. Included in the line are: Feeder-orientors for handling fragile and highly finished parts, elevating oriented feed hoppers, stack feeders, and rotary hoppers. Automatic transfer and storage units are also covered, and notes on electronic comparators, automatic grinder control systems, and hardness testing machines are given.

Circle 507 on Page 133

Crane Electrification

Cleveland Crane & Engineering Co., Wickliffe, Ohio—8 page bulletin—Aluminum inverted-Y conductor systems are discussed in Booklet 1. Data are given on crane and runway electrification for general industrial usage requiring currents of 500 to 1200 amp. The equipment includes fittings and current collectors for conductor systems mounted on either wall or ceiling.

Circle 508 on Page 133

Socket Screw Products

Set Screw & Mfg. Co., Bartlett, Ill.—28 page catalog—Socket shoulder screws, flat heads, button heads, and dowel pins are among units described in Catalog 23. Tables list thread data and a detailed selector chart is given to aid in choosing the correct screw for different applications. Also explained is the operation of a hopper feeding mechanism which is designed for headless setscrews.

Circle 509 on Page 133

Thermocouple Assemblies

Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.—36 page catalog—Thermocouple assemblies and pressure sealing glands are covered in Catalog 1885. Included in the line are bare wire thermocouple glands, roll temperature thermocouples, safetywell thermocouples, and packing glands. Assembly instructions are given and there are notes and illustrations of special assemblies.

Circle 510 on Page 133

Process Instruments

Fischer & Porter Co., 941 Jacksonville Rd., Hatboro, Pa.—52 page catalog—Data are given in Catalog 2 on process instruments such as indicators, transmitters, recorders, and controllers for flow, pressure, temperature, density, viscosity, and consistency. Construction materials of the different instruments are listed. Also included are sizing nomographs for variable-area flowmeters. Numerous other charts show valve characteristics, pressure ratings for flow indicators, and fluid velocity in magnetic flowmeters.

Circle 511 on Page 133

Gearshift Drives

Lima Electric Motor Co. Inc., Dept. 286, Lima, Ohio—8 page bulletin—Bulletin OEM-DB is a comparison study of gearshift drives. The mechanical and physical characteristics of the drives are compared to other basic types. Also included are illustrative examples of various applications.

Circle 512 on Page 133

Reduced Voltage Starters

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.—12 page booklet—Automatic reduced voltage starters, ranging from 50 to 1200 hp, 600 v are described in Bulletin 14B8192. Their applications on centrifugal compressors, hammer mills, pumps, and motor-generator sets are discussed. Also noted are starting characteristic calculations, horsepower ratings, and features of the contactors, relays, and fuses.

Circle 513 on Page 133

Numerical Control Unit

Electronic Control Systems Div., Stromberg-Carlson Co., 2231 S. Barrington Ave., Los Angeles 64, Calif.—4 page pamphlet—Digimatic Control System, an automatic control system for table positioning, is the subject of brochure. The three operating units—tape preparation unit, control unit, and compound servo table—are described and illustrated. Step-by-step procedure is given for automatic drilling and a cost comparison made for hand drilling of the same part.

Circle 514 on Page 133

Time Delay Timers

Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.—4 page pamphlet—Synchronous motor driven time delay timers with automatic reset are outlined in Bulletin 300. The units are applicable on induction heating equipment, packaging equipment, plastic mold-

ing machinery, and electric welders. Diagrams show the external clutch and time delay circuit, and tables list time cycles for the different styles.

Circle 515 on Page 133

Hydraulic Power Units

Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio—4 page pamphlet—Line of hydraulic pumps, motors, and controls is outlined in Bulletin 146-E. Constant volume and variable volume hydraulic pumps and pumping units for service up to 5000 psi are covered. Data are also included on 4-way valves and flow controls.

Circle 516 on Page 133

Solenoid Valves

J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18, Ind.—4 page pamphlet—Line of solenoid valves, in sizes from ⅜-inch to 3 inches, for pressures to 400 psi is outlined in Bulletin 500C. Cutaway drawings show the details of a valve in both open and closed position. Variations from the basic type of valve are also listed.

Circle 517 on Page 133

Synchronous Motors

Electric Indicator Co. Inc., Camp Ave., Stamford, Conn.—28 page catalog—Line of synchronous motors is described in Catalog EI-4. Types of motors include hysteresis, polarized, and stabilized hysteresis—in single and multispeed styles. Tables show specifications on the electrical, physical, and performance characteristics of the different types. Also provided is technical data on the theory and application of all types of synchronous motors.

Circle 518 on Page 133

Indexing Machine Chassis

Swanson-Erie Corp., 814 E. 8th St., Erie, Pa.—8 page bulletin—Features of Series B and Series C, turret type indexing machine chassis are discussed. Some of the features include: Positive locking device, indexing mechanism, and the provisions for tool mounting. Operational data are listed and sketches show tool mounting brackets and dimensional specifications.

Circle 519 on Page 133

Conveyor Furnaces

C. I. Hayes Inc., 808 Wellington Ave., Cranston 10, R. I.—4 page pamphlet—Conveyor furnaces, outlined in Bulletin 5711A, are designed to put heat treating operations on a production basis. Sketches show the construction of the furnaces and method of obtaining uniform heat distribution. Design features such as a variable speed electronic drive, automatic temperature controls, and sinuous wound ribbon type heating elements, are described.

Circle 520 on Page 133

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408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
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432	472	512	552	592	632	672	712	752	792	832
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435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	759	799	839
440	480	520	560	600	640	680	720	760	800	840

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Process Equipment

Fuller Co., Catasauqua, Pa.—12 *page booklet*—Equipment for the process industries is described in Bulletin G-3B. Equipment includes pumps, pneumatic conveyors, fluidizing conveyors, rotary compressors, and vacuum pumps. Operating principles are explained and photos show typical installations. Schematic drawings and performance characteristics are included.

Circle 521 on Page 133

Pneumatic Temperature Controls

Partlow Corp., New Hartford, N. Y.—4 *page pamphlet*—Data are given on two pneumatic temperature controls—Model RVA, a recording unit and Model IVA, an indicating unit. The mercury expansion principle and valve operation are discussed. Photos show the accessories which are used to make up various pneumatic control systems.

Circle 522 on Page 133

Cold-Drawn Tubing

Superior Tube Co., 1727 *Germantown Ave., Norristown, Pa.*—10 *page bulletin*—Cold-drawn materials in small tubing forms are discussed in Bulletin 41. The materials, such as stainless steel, carbon steels, alloy steels, and nickel and nickel alloys, are listed in tables which give their characteristics and applications. Other charts show normal size limits of available tubing.

Circle 523 on Page 133

Automatic Bagging Scale

Richardson Scale Co., Clifton, N. J.—6 *page pamphlet*—Bulletin 3749B describes Model E-50, an automatic bagging scale which can handle fertilizer, feeds, grains, cement, rock products, chemicals, food products, and silimar materials. Data on the unit's capacities, gravity or power feed operation, and material discharge are given. Accessories are also mentioned.

Circle 524 on Page 133

Connectors & Adapters

Cannon Electric Co., 3208 *Humboldt St., Los Angeles* 31, *Calif.*—16 *page booklet*—Data are contained in Catalog ALRF-1 on line of coaxial connectors and cable adapters which use aluminum shells. Functional diagrams and cable trim instructions are given. Charts show the results of sample tests of typical assemblies.

Circle 525 on Page 133

Packaging Machinery

Packaging Machinery Div., Food Machinery & Chemical Corp., 4900 *Summerdale Ave., Philadelphia* 24, *Pa.* — 4 *page pamphlet*—Line of automatic packaging machinery is described and illustrated in Bulletin P-809. Equipment in the line includes: Fillers, checkweighers, carton filling and sealing machines, casers, contour wrapping machines, box and tray forming equipment, wrapping machines, and paper box machinery. Specifications, production rates, and application are noted.

Circle 526 on Page 133

Variable Speed Drives

Marathon Electric Mfg. Corp., Wausau, Wis., 4 *page pamphlet*—A three-element unit which provides dc variable speed drive from an ac network, is described in Bulletin SB-183. Data are given on the components in the unit and a schematic drawing illustrates the principle of operation. Auxiliary equipment such as motor enclosures and control panels are also covered.

Circle 527 on Page 133

Transformers

Chicago Standard Transformer Corp., 3501 *W. Addison St., Chicago* 18, *Ill.*— 32 *page catalog*—Line of transformers for various applications is outlined in Catalog S-104. Electrical and physical specifications are listed and output transformer charts and performance curves included. Drawings show the numerous types of mounting styles.

Circle 528 on Page 133

Testing Equipment

George L. Nankervis Co., 15300 *Fullerton Ave., Detroit* 27, *Mich.*— 6 *page* pamphlet—Equipment is described in Bulletin 1374 which is designed for testing hydraulic, electronic, mechanical, and pneumatic units as well as liquid flow measuring instruments. Illustrations show the steps involved in developing this equipment. The company's facilities are also discussed.

Circle 529 on Page 133

Conveyor Scales and Feeders

ABC Scale Div., McDowell Co. Inc., 16300 *Waterloo Rd., Cleveland* 10, *Ohio* — 16 *page booklet* — Blending conveyor scales and feeders for weighing, totalizing, and controlling the flow of bulk materials are described in Bulletin 100A. Construction and operation are explained, aided by sketches. Applicational photos of both the scales and feeders are given. Also included are illustrations of different accessories.

Circle 530 on Page 133

Finished Bore Sprockets

Acme Chain Corp., Holyoke, Mass.— 4 *page pamphlet*—Specifications and prices for 99 sprocket sizes and 933 different bores are contained in Bulletin 3. Notes on construction materials are given and charts list standard keyways and setscrews.

Circle 531 on Page 133

Open Back Inclined Presses

Clearing Machine Corp., Div., U. S. Industries Inc., 6499 *W. 65th St., Chicago* 38, *Ill.*— 8 *page bulletin*—Bulletin SB19.84 contains information on presses in 22, 32, and 45 ton capacities. Some of the points covered include: Lubrication, eccentric shaft design, and safety features. Illustrations show the different components in the press.

Circle 532 on Page 133

Vertical Hydraulic Machines

Baker Bros. Inc., 1000 *Post St., Toledo* 10, *Ohio*—16 *page booklet*—Vertical hydraulic drilling and tapping machines in 12, 18, and 24-inch way widths are described in Bulletin 615. Data and charts on spindle speeds are given and photos show the design features. Floor plans and dimensions are also included.

Circle 533 on Page 133

Welding Head Control

Pandjiris Weldment Co., 5151 *Northrup Ave., St. Louis* 10, *Mo.*—6 *page* pamphlet—Data are contained in Bulletin 4457 on manipulators for directional welding head control. Photos display the control unit which can perform 27 operating functions. A photograph shows a manipulator in use in a production operation.

Circle 534 on Page 133

Intermittent Duty Motor

Bodine Electric Co., 2254 *W. Ohio St., Chicago* 12, *Ill.*—4 *page pamphlet*—Construction and operation of Model FSE-23, a series wound, self ventilated, 1/40 hp motor is explained in Bulletin 1034. Dimensional sketches are given for the motor which is applicable on actuators, adding machines, and calculators. Features are also noted.

Circle 535 on Page 133

Quick Coupling Assemblies

Jordan Industrial Sales Div., OPW Corp., 6013 *Wiehe Rd., Cincinnati* 13, *Ohio*—8 *page bulletin*—Quick coupling assemblies which can be used with hoses or pipes are described in Bulletin F-10-R. Data are given on the different styles and special assemblies. Charts list recommendations for operating conditions and chemical service.

Circle 536 on Page 133

Static Switching Circuits

Scam Instrument Corp., 1811 *W. Irving Park Rd., Chicago* 13, *Ill.*—6 *page pamphlet*—Data on monitoring systems with static switching circuits are contained in Bulletin 1058. The different models and sizes are illustrated. Also included are notes on extra optional equipment.

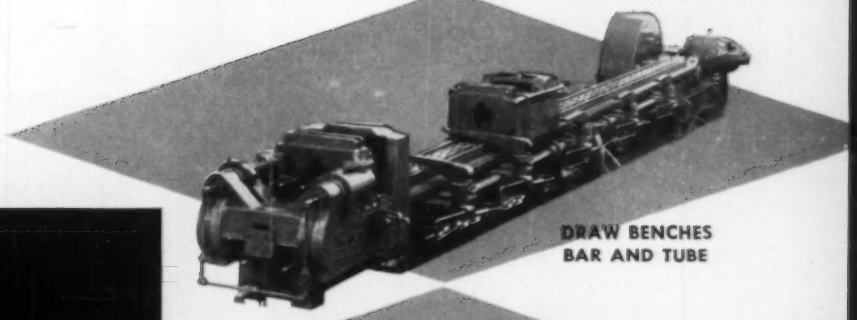
Circle 537 on Page 133

Rotating & Control Equipment

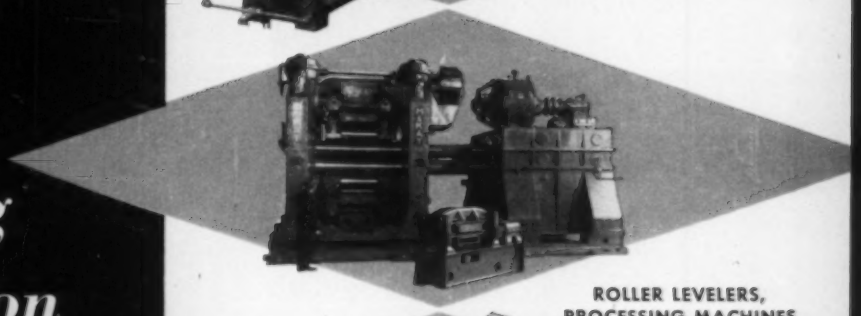
Electrical Div., Safety Industries Inc., P. O. Box 904, *New Haven* 4, *Conn.*—6 *page pamphlet*—Data on rotating and control equipment are contained in Bulletin 4988. Equipment described includes: Motors, generators, alternators, motor-generators, magnetic amplifiers, regulators, and relays. Features and applications are noted.

Circle 538 on Page 133

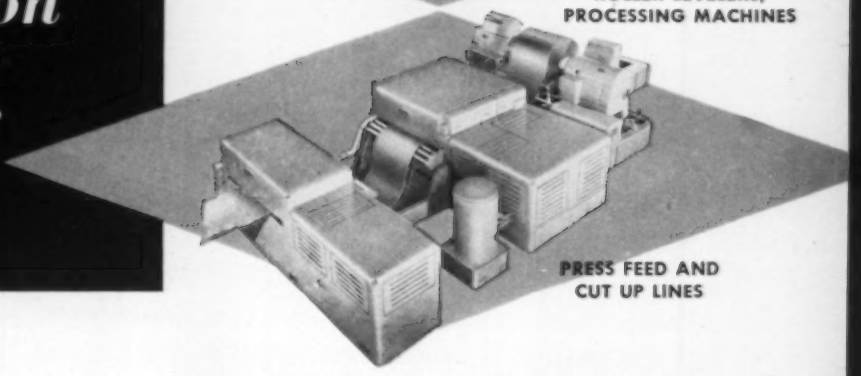
TUBE MILLS AND
FORMING MACHINES



DRAW BENCHES
BAR AND TUBE



ROLLER LEVELERS,
PROCESSING MACHINES



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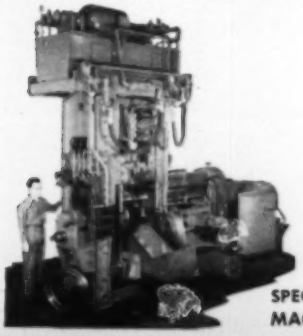
Circle 652 on Page 133



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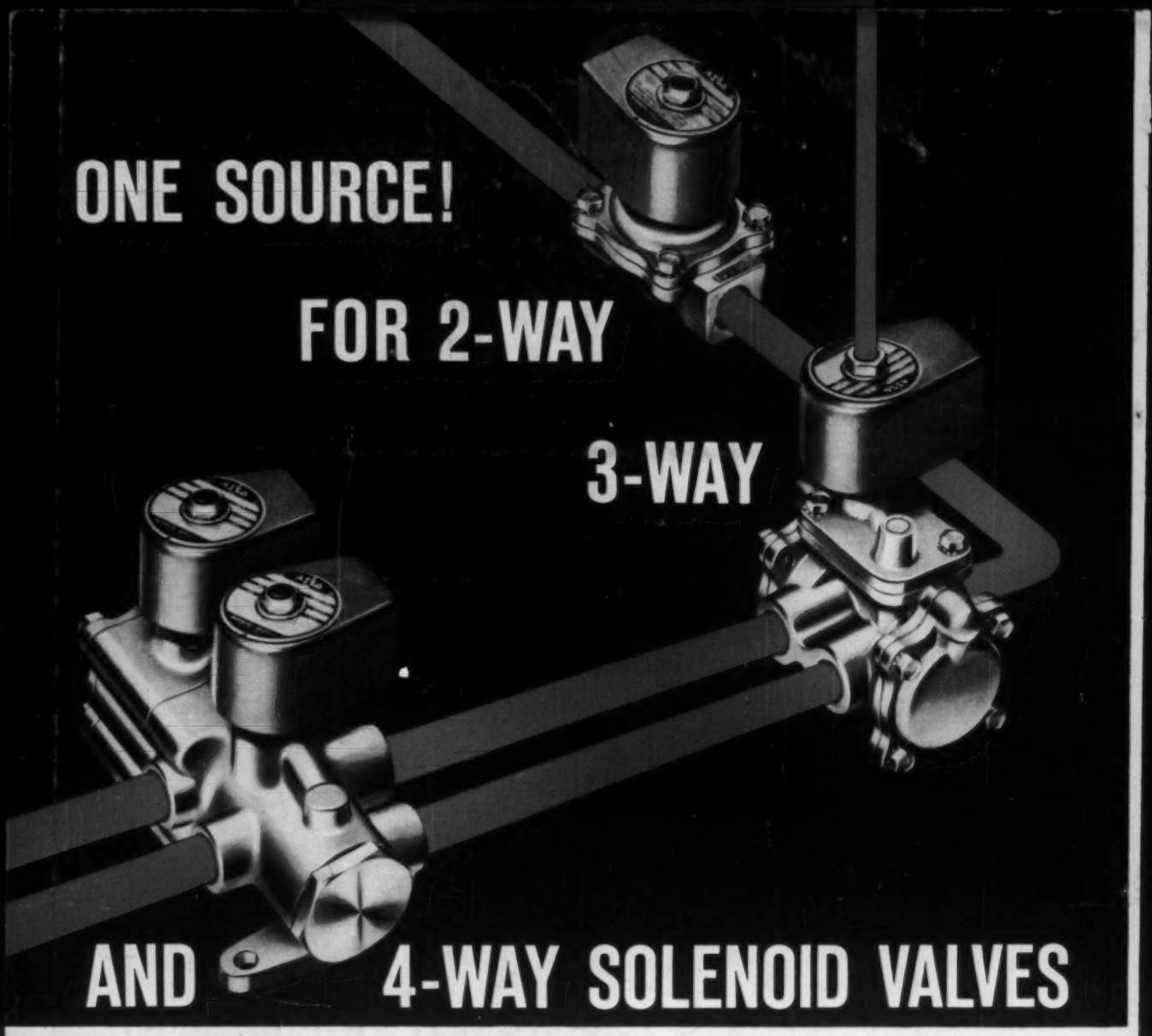

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Circle 653 on Page 133